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RADON CONTAMINATION PROBLEMS IN NORTH DAKOTA

HEARING

BEFORE THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

FIRST SESSION

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RADON CONTAMINATION PROBLEMS IN NORTH DAKOTA

THURSDAY, AUGUST 20, 1987

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Fargo, ND.

The committee met, pursuant to notice, at 1:30 p.m., at the Fargo Holiday Inn, I-29 and 13th Avenue South, Fargo, North Dakota, Hon. Quentin N. Burdick [chairman of the committee], presiding.

Present: Senator Burdick.

OPENING STATEMENT OF HON. QUENTIN N. BURDICK, U.S. SENATOR FROM THE STATE OF NORTH DAKOTA

Senator BURDICK. Good afternoon, ladies and gentlemen. I would like to welcome you to this hearing on issues related to radon gas. In recent years we have become increasingly aware of radon. A number of studies indicate that radon may be among the Nation's largest and least addressed health problem.

The purpose of today's hearing is to learn about the radon contamination problem in North Dakota. We will also learn of the steps taken by State agencies, the Federal Government, and others to respond to the radon problem. Radon is a naturally occurring gas which seeps into homes and buildings and can build up to hazardous levels. Exposure to radon poses a significant threat of lung cancer, second only to cigarette smoking.

The Environmental Protection Agency estimates that as many as 20,000 lung cancer deaths each year are caused by radon. EPA also estimates that as many as 10 percent of the 85 million homes in the Nation may have radon at hazardous levels.

The EPA recently published new information about the extent of radon contamination in 10 States. Elevated radon levels were found in every State surveyed. Colorado had the most homes with high radon levels, at 39 percent; and over 20 percent of all homes in Kansas, Wyoming, and Wisconsin held high radon levels. These States join Florida, New York, New Jersey, Pennsylvania, and Maine as having significant radon problems.

Here in North Dakota there is evidence of radon contamination. Almost 200 homes have been tested in over 25 cities and towns throughout the State. Based on this data, the Department of Health estimates that as many as 50 percent of all homes in the State may have radon levels above the EPA-recommended safety level. Areas of the State where radon is of concern include Grand

Forks, Fargo, Bismarck, and generally the southwestern part of the State.

The State has taken several actions to respond to the radon problem. Over the next year the Department of Health will work with the EPA to develop a statistical survey of radon levels in homes throughout North Dakota, and the department will continue to demonstrate radon reduction methods in some homes.

The increase in attention to the radon problem has increased public demand for action. Much of this increased demand is falling on State Governments. Many States such as North Dakota would benefit from financial and technical assistance from the Federal Government in development of radon programs.

The Committee on Environment and Public Works, which I chair, recently developed and passed a bill entitled the Radon Program Development Act. The bill will provide seed money to help States get radon programs up and running.

States can use this Federal assistance for a wide variety of activities. Eligible activities include surveys of radon problems, development of educational materials, purchase of laboratory and related radon measurement equipment, and setting up data management systems. The bill provides national funding of $10 million a year for the next three years, to be divided among the States.

This legislation also directs the Environmental Protection Agency to determine the extent of radon contamination in the Nation's schools. There is evidence of high radon levels in schools in some parts of the country, and there is concern that children may be particularly sensitive to radon.

The radon bill also requires the EPA to conduct a survey of radon in Federal buildings and to expand its program to assure the proficiency of private firms offering radon testing and mitigating services.

I am very pleased to report that the Senate passed this important legislation in July of this year. However, the bill has a long road before it is finally enacted. The House of Representatives will hold hearings on a bill in the fall. Once the House passes a bill, a conference of the House and Senate members will meet to resolve differences between the two bills.

I plan to stay involved in the development of this important legislation and to do whatever I can to improve the bill and ensure its enactment as soon as possible. I will continue to press the EPA to expand technical assistance to States for radon projects such as the State survey project to be conducted in North Dakota over the next year.

We are fortunate to have a number of extremely qualified witnesses from around the State with us today. I want to thank each of them for making themselves available to the committee.

At this point, we will proceed with our first panel.

I might say at this time that I am very pleased that the witnesses have volunteered to appear here and that we should have a very good hearing. I would ask that the witnesses not be overly lengthy in their testimony. We prefer five minutes, but we won't hold you to that, but just ask that you be cooperative.

I might say before the hearing gets started that I have at the back of the room a bulletin entitled "Radon Reduction Methods: A

Homeowner's Guide." They will be available if you care to have them after the meeting is over. It contains some very valuable information.

So, let us start now with our first witnesses. It will be composed of panel number one: Goodwin Hoff, from the City of Fargo; Dana Mount, Department of Health; and Jim Scherer, regional administrator, Environmental Protection Agency, region VIII, Denver.

Gentlemen, you may proceed as you wish.

STATEMENT OF GOODWIN HOFF, SUPERVISING SANITARIAN, ENVIRONMENTAL HEALTH SERVICE, CITY OF FARGO, ND

Mr. HOFF. Thank you, Senator Burdick. Having a home in Fargo, you hardly need to be welcomed to Fargo, but on behalf of Mayor Jon Lindgren, who is unable to be here, and the City of Fargo, I welcome you home. Thank you for bringing your Senate Committee on Environment and Public Works to Fargo for this very important hearing.

The public has become concerned with the threat to human health by possible exposure to radon gas in our homes. Radon gas and its link to cancer have caused all of us to become very aware of our environment, and probably most important, our homes, where we spend so much time.

In early reports the news media mentioned Fargo as an area where the study indicated that homes in our city had recorded some of the highest levels of radon found in our Nation. That study, however, was limited to a survey of only a very few of the thousands of residences in our city and may well have included dwellings that, because of poor construction and other factors, may well be expected to result in high radon levels.

However, the publicity caused concern that was expressed to our department by the public. Since that time, because of the natural occurrence of radon in area soils, we have become much more aware of proper construction of the homes as well as the importance of exhausting systems and other methods that may reduce the levels of radon and dissipate radon gas levels in our homes.

Most people that contact our department don't really know what they're worrying about. They don't know if they have radon in their homes. They don't know at what level of radon their health and well-being will be threatened. They don't know how to get their homes tested, and in many cases they don't know what to do or how to interpret the results once they receive them.

As a community health center, we are primarily interested in two aspects of the radon problem. First, we would like to have some definitive information on radon: at what levels is the problem real and a realistic threat to human health?

Second, what can we do to serve the public? How can we respond to requests for testing homes? Should we continue to encourage the people to use monitoring devices that are available from vendors, or will testing devices and services become available through State and Federal agencies? Can we become involved in programs such as education that can provide reliable information to the public to answer these concerns?

We know that radon gas occurs naturally in varying concentrations in soils and rocks in our area and that concentrations have been measured in a number of homes that exceed the EPA levels, that radioactive decay products of radon have been shown to increase the risk of lung cancer, as you have referred to.

We would like to determine the degree of risk to our citizens as well as the amount of health risk associated with radon and its decaying products. And as a community health center, we are looking forward to the leadership of State and Federal agencies to provide those answers. Thank you.

Senator BURDICK. To what extent do you think that the people of Fargo are aware of the potential danger?

Mr. HOFF. During the previous 8 months of this year we have had 26 calls that have been recorded by our department, and while there is some ongoing concern, I think the dates of those calls to our department indicate that most of the information is a response to the publicity on radon. When radon news occurs in the media, we receive more calls. People become more concerned.

But as I say, I think at this time people are confused about radon, they are looking for more information. They don't know really what they're worrying about. They don't know for sure are four picocuries of radon gas in their home going to cause them to be one of the 20,000 cases of lung cancer or whatever it might be.

Senator BURDICK. Have there been any spot checks in Fargo?

Mr. HOFF. There are agencies and individuals doing some checks in Fargo. I believe they may be working with the State Department of Health that Mr. Mount may talk about. However, most of these people that we visit with are being referred to vendors of various monitoring devices that they can use for themselves in the homes and return them to the vendor for analysis.

Senator BURDICK. Thank you.

Dana Mount.

STATEMENT OF DANA MOUNT, DIRECTOR, ENVIRONMENTAL ENGINEERING, NORTH DAKOTA DEPARTMENT OF HEALTH

Mr. MOUNT. Thank you for inviting me to testify here, Chairman Burdick. It is a pleasure to be here. I am the director of the Division of Environmental Engineering of the North Dakota State Department of Health and Consolidated Laboratories. We are located in Bismarck. The Department is responsible for implementing the State's radiation control program and is consequently responsible for development of the State's radon program.

It is a pleasure to be here today to testify on the nature and extent of radon contamination in North Dakota and the steps being taken by the Department to respond to the problem. Other panelists will be giving detailed information on what radon is, where it comes from, and what the health effects are. I would therefore like to talk briefly about how radon gets into a home, how it is detected, where detectors can be obtained, how the detectors are used, what test results mean, how radon can be mitigated, what the role of the Department has been, what radon levels have been measured in North Dakota, and what we see as the future in North Dakota.

Radon can get into a home through the soil the home is built on, from building materials the home is built of, and from water supplies to the home. In North Dakota we have found that the soil is the major source of radon in homes. We have not experienced any building materials that appear to be high in radon content here.

Also, a study done by EPA with the Department of Health a few years ago found that radon in groundwaters in the State is relatively low. So we do not feel that the water supplies from wells of individual houses is a major problem here. However, that was a study of only 60-some wells across the State. So more research probably needs to be done there. So, in conclusion, the soils that the houses are built on and the type of construction is the main problem with radon in North Dakota.

Since radon cannot be seen or smelled, special equipment is needed to detect it. The two most popular devices that are available are the charcoal canister and the alpha track detector. Both of these devices are exposed to the air in a home for a specified period of time and are sent to a laboratory for analysis. These are the devices that have been used by homeowners in the State of North Dakota to analyze their homes.

The concentration of radon in air is measured in units of picocuries per liter of air, and one picocurie per liter represents the decay of two radon atoms per minute in a liter volume of air. The concentration of radon decay products in air are measured in units of working levels. One working level of radon decay products roughly corresponds to the amount of decay products released by 200 picocuries per liter of radon in the air.

There are other techniques requiring operation by trained personnel which can be used to measure radon levels, but such techniques may be more expensive than the devices indicated above. Therefore, we recommend the two screening devices for use by the homeowners to initially screen their homes.

Homeowners in North Dakota have been and are encouraged to contact the Department of Health whereby we will provide the homeowner a copy of the EPA pamphlet "A Citizen's Guide to Radon," which includes some of the information I am providing today. We also provide them a list of companies that provide radon testing services. All of the companies on our list we provide have successfully demonstrated their capabilities in measuring indoor radon through the EPA radon measurement proficiency program.

The cost in North Dakota for having a home tested ranges from about $13 to $50, depending on the company, type, and number of detectors one wishes to purchase. We would like to say that the pamphlets EPA has put out and the proficiency testing program has greatly helped our job in providing information to our citizens.

I might mention we have had a few cases of individuals who have been concerned about radon that felt they couldn't even afford the minimal charge, and sometimes we would then do a screening for them. But we haven't had to do that very often. Most people, I think, can afford the cost of the detectors so far.

The EPA and this Department recommends a quick and relatively inexpensive initial screening test. If the results indicate the possibility of high radon levels, then follow-up measurements should

be taken to provide a more precise picture of the average concentrations throughout a home.

The Department has adopted EPA-developed testing protocols providing detailed information on proper testing procedures.

A screening test is a short-term measurement made to give the homeowner an idea of the highest radon level in their home. The screening measurement is made in the lowest livable area of the home, the basement if there is one. All windows and doors are to be kept closed for at least 12 hours prior to the start of the test and kept closed as much as possible throughout the testing period. This is necessary to keep the radon level relatively constant throughout the testing period.

Because of the need to keep the windows closed as much as possible, it is recommended that these short-term radon measurements be made during the cool months of the year. Also, it is suspected that higher radon levels are more probable in homes in North Dakota during the cool months or winter season. I guess we all know we have a longer winter season here in North Dakota than most parts of the country as well. So we have the potential of a bigger problem from the weather as well.

In most cases, the screening measurement is not a reliable measure of the average radon level to which a homeowner and his family are exposed. This is what the EPA guidelines are based on, an average annual exposure.

Since the radon levels can vary greatly from season to season as well as from room to room, the screening measurement only serves to indicate the potential for a radon problem. Depending on the result of a screening measurement, follow-up measurements may be needed to give a better indication of the average radon level in a home.

Generally, the follow-up measurements are made over a period of a year. The department strongly recommends that follow-up measurements be made before a homeowner makes any final decisions about whether to undertake major efforts to permanently correct potential radon problems. We don't want people rushing in and spending a lot of money unnecessarily. From most of the data we find there isn't a critical rush that they cannot wait a year's time to do additional testing and work out a plan. So far we haven't found any super-high houses that would require immediate vacancy or things like that yet.

Once the homeowner receives the results from the vendor, the Department then requests the homeowner contact the Department and tell us what the results are. Then we can sit down with them and discuss further actions and mitigation measures, if needed. We work with them to effectively decide what they should do.

If the screening results are above four picocuries per liter, then follow-up measurements should be performed. If follow-up test results are above four picocuries per liter, then mitigative measures should be considered to permanently reduce radon levels as much as possible.

The higher the radon concentration is, the higher the risk of developing lung cancer. The higher the radon level in a home, the quicker the mitigative action should be taken, of course.

The risk of lung cancer from exposure to radon depends on the amount of radon entering a home and the length of time it remains in living areas. Some actions which may be taken immediately to reduce the risk of radon which can be done quickly and with a minimum of expense are: stop smoking and discourage smoking in the home. By doing so, it should reduce the family's overall chance of developing lung cancer as well as reducing the family's risk from radon exposure. The radon decay products will attach themselves to smoke particles which may become lodged in the lung through inhalation, and reducing these particles in the air then reduces the risk in radon.

Then, of course, as a Health Department, we do not promote smoking either. So that is a benefit as well, to quit smoking.

Another immediate action one can take is to spend less time in areas with the higher radon concentrations, such as the basement. The basement is closest to the soil, has probably the poorest ventilation, and we find basement levels are much higher than, say, first-floor or second-floor levels. So if you can avoid being in your basement as much, that is a thing to do.

Whenever practical, open all windows and turn on fans to increase the air flow into and through the house. This is especially important in the basement again. If a home has a crawl space underneath it, the crawl space vents can be kept open on all sides all year. The problems with these things is that it adds to the heating bill. If you bring in more air, you are going to have to pay more to keep your house warm.

While the above actions will reduce the risk of radon, they generally do not offer long-term solutions. Some long-term solutions are: sealing the house off by plugging up cracks in the floors. We found homes that have sumps for water problems that are vented right into the basement of the house. We have seen reductions by venting sumps to the outside. So anything you can do to seal off entry routes is a part of the permanent solution.

Putting in air exchangers, heat exchangers, to increase the home ventilation and minimize the cost of energy from that is another good way.

Also, putting ventilating pipes under the floors to ventilate the soil and get the radon away from the basement of the house can be done. This we haven't tried yet in North Dakota. We have tried air-to-air heat exchangers and sealing and sump venting to the outside, and these seem to work well in North Dakota.

No one technique can be relied on to consistently reduce radon levels in every house. Each house must be evaluated on a case-by-case basis to determine the source of the potential entry routes and develop a solution before any mitigation approach is adopted. EPA has successfully reduced radon levels in a number of houses and is continuing research on a variety of mitigation techniques. I think North Dakota may be a good place for EPA to do some demonstration and research in this area as well.

What has the Department's role been in the past several years? The department became involved in radon measurement in the fall of 1983 as a result of studies being conducted jointly by the Department and EPA Region VIII in Denver as well as the EPA radiation laboratory out of Las Vegas. This work was related to the reclama-

tion of abandoned uraniferous lignite mines in the western part of the State near the City of Belfield.

To determine the impact of these mine sites and any underlying uraniferous lignite ore bodies, the Department and EPA placed a number of alpha track detectors in homes surrounding these mines. The results of this limited study led the Department and EPA to conduct measurements in some of the homes in the area, using radon progeny integrating sampling units (RPISU's) and passive environmental radon monitors (PERM's). These measurements were conducted through the summer of 1984.

Because of limited financial resources, the Department used and continues to use equipment on loan from EPA as well as the laboratory services of EPA. We wish to thank EPA for providing generous amounts of equipment and support to us. We would be nowhere near where we are now without the help of EPA.

In 1984 and 1985 measurements were made in some additional homes in the Belfield area as radon gained more attention by the media on the local as well as the national level. We did find many homes in the Belfield area that do have somewhat elevated levels of radon in them.

In November of 1985 a study by Lawrence Berkeley Laboratories was published in Popular Science magazine. This article indicated that 35 percent of the homes in Fargo could be projected to have levels exceeding eight picocuries per liter, a level twice the EPA-recommended guidelines. I think in this study they only checked about 11 homes in the Fargo area.

Since that time, interest in the radon issue has risen to a level that has resulted in the Department becoming more active in conducting measurements in all areas of the State. At that time, the Department began making measurements in homes upon request, using RPISU's and PERM's and then offering suggestions on remedial actions, if necessary, which the homeowner might wish to consider.

Since approximately mid-1986, because of the Department's limited resources, measurements in private homes have still been made, using RPISU's and PERM's but only after the homeowner has utilized the services of a private vendor for radon testing and reporting any elevated measurement results above four picocuries per liter to the Department.

Since January of 1987, because of the greater workload that we have seen, we have selected a level of eight picocuries per liter or greater before performing follow-up measurements with the RPISU's and PERM's. At levels between four and eight, we now ask the homeowner to consider purchasing an alpha track detector to determine annual average rate on concentrations.

The eight-picocuries-per-liter level was established by the Department for the purpose of maintaining a priority workload. There again, any funding through Congress would definitely help our program by allowing us to get more equipment and more staff to provide more direct service to the homeowners.

What levels have we seen in North Dakota? Vendor results, as reported by 114 homeowners, indicate that approximately 50 percent of the homes in North Dakota that have been monitored have radon concentrations that equal to or exceed four picocuries per

liter. We have followed up with our RPISU and DERM measurements with approximately 120 measurements. While our data is biased because we were following up on some of the homes that have had high levels, we have confirmed that we see these many higher values in North Dakota.

We have collected data in 28 cities in the State, of which 20 have at least one home with radon levels exceeding the EPA screening guidelines. The range of radon screening results reported at the Department is from less than one picocurie per liter to 247 picocuries per liter. Follow-up measurements conducted by the Department have not shown any levels greater than 40 picocuries per liter.

Mitigative measures have been completed or are being attempted in approximately 12 homes at this time. These mitigative measures have included sealing cracks in basement foundations, venting sump soil gas outside, and installing air-to-air heat exchangers. Some other homeowners which have elevated screening test results are using alpha track detectors to determine the annual average radon concentration in their home prior to considering any remedial action.

The Department is essentially following the EPA's guidance as published in the EPA pamphlet "A Citizen's Guide to Radon" and the "Radon Reduction Methods," the blue book.

Recently, the Department submitted a proposal to participate in the EPA's States assistance program whereby a Statewide radiation survey will be initiated during the fall of this year. Also, I believe, Minnesota is going to be doing one of these.

In August we were informed by EPA that we have been approved to participate in the program this fall. The Department expects to receive approximately 3,000 charcoal canisters for random radon screening tests. A total of 2,400 randomly selected homes will be tested across the State. The survey should provide valuable information to estimate the scope of the radon problem in North Dakota.

Right now we know we have a problem in the Red River Valley from Fargo to the Canadian border and in the southwestern part of the State. But we have also had elevated levels in the Jamestown area, Bismarck area, and Minot area, not as many as in the eastern part or the southwestern part, but I think we will find that you can find them anywhere in the State.

In the future, Federal legislation such as the Radon Program Development Act of 1987, recently passed by the Senate, would provide greatly needed technical and financial assistance to States such as North Dakota. The Department is concerned that North Dakota has a radon problem but we do not have the resources to investigate, educate, and mitigate the problem such as we think is needed. That is why we enthusiastically support this Act and hope it is passed by the House as well as it has been by the Senate. It will definitely provide technical assistance to the State through EPA to expand what we are already getting and definitely the funding to develop a program in North Dakota will be of great benefit to the State.

That concludes my prepared testimony, and I appreciate your giving us the opportunity to testify here today in Fargo instead of

in Washington. If you have any questions, I would be happy to answer them.

Senator BURDICK. In the bill we passed in the Senate, we provided $10 million for the next 3 years, $30 million total.

Mr. MOUNT. Yes.

Senator BURDICK. Would you say that would be adequate for the investigative work that you are going to have to carry on?

Mr. MOUNT. I guess I feel that if every State and territory would apply for that, it would probably be quite thin in some of the States, you know.

I guess I am also concerned, too, that it will establish a radon program but we have to wait and see what our legislature in 1989 will do as far as providing funds to maintain the program. Maybe the Congress should look at a maintenance program of, say, 50–50 State-Federal funding or some funding for a longer time than three years.

I guess I sort of feel that it is going to take much more than three years before the problem is contained and under control, so to speak.

Senator BURDICK. The 3-year program and the $30 million was just a start.

Mr. MOUNT. A start.

Senator BURDICK. It's a start to form the basis for what is to come.

Mr. MOUNT. Right.

Senator BURDICK. This is not going to provide any money for the householder yet.

Mr. MOUNT. Yes. That is another area I think that Congress is going to have to look at: Do we need some type of an income tax break for the expenditures a homeowner does? Do we need a loan or a grant program to assist low-income homeowners or any type of homeowner? You know, EPA should possibly study: Do we need national building codes for new-home construction, things like that, or laws to protect buyers and sellers of homes, requiring testing of houses and things like that. There is a lot of areas for Federal involvement there as well as things that could be done on the State level, too.

Senator BURDICK. Are you talking about a cost-sharing program between the State and the Federal Government?

Mr. MOUNT. I suspect that would be a fair thing. You know, it's both the State and the Federal Government's responsibility as it is a naturally occurring thing and not really caused by either the Federal or the State Government. I think we all have to work together to have something to minimize the risk to the citizens.

Senator BURDICK. To put it simply, do you think that the three-year program will put us in a position to know what to do and where we're going at the end of that period?

Mr. MOUNT. I think so, yes. Then we have to figure out how we're going to do it, after we know what it's going to cost over the long haul and things like that.

Senator BURDICK. Do you think we have enough evidence in the record right now to start the construction work to aid the citizens at this point?

Mr. MOUNT. I believe so, yes. The greater number of homes that we can test, we are going to find a large number of homes that are going to be above the guidelines and in which mitigation should be done in them, and we are going to find some people that can afford it and others who can't. Anything we can do to create an incentive for people to do the work is definitely going to affect lung cancer and the health risks over the long haul.

Senator BURDICK. Well, certainly in the next 3 years we are going find out a little bit more about this terrible thing.

Mr. MOUNT. Definitely so.

Senator BURDICK. We may have some different methods we might employ in combatting it, too.

Mr. MOUNT. That's right. Yes. Anything that is more effective and less costly is going to be needed. Homeowners are going to be reluctant to spend $2,000 or $3,000. And I guess in some of the cases in Pennsylvania they have had to spend more than the cost of the home.

Senator BURDICK. That brings me to another question. I have been told that in other parts of the country there have been some fast operators that have promised things they couldn't deliver and they rip off the citizens. How do we prevent that?

Mr. MOUNT. I think there we are going to need some type of legislation and a certification or a registration program where we certify the testers, require auditing by the State Government of these people, and also some type of a program to ensure that contractors that are doing the remedial action are overseen so that they know what they're doing and are being fair about it.

We have not seen too many cases in North Dakota of unscrupulous operators, but in one case we felt a bid to put a sump vent on was excessive compared to some other prices we've seen.

We did have an inquiry from a person wanting to know if he could get approval for pumping a chemical around the foundations and under the walls to seal it, and he wanted approval to run with that, which we felt he didn't know what he was doing and was kind of shaky there.

So we are just starting to see that, and I think that in other parts of the country it's probably a bigger problem already. But I think that is going to come, you know, that there is going to be opportunistic people that are going to take advantage of the thing. So something has to be set up in advance to minimize that.

Senator BURDICK. What would you say about EPA approval of the contractor? Would that help?

Mr. MOUNT. I think some type of approval program would help, yes. Now, whether it should be a national thing, I'm not sure. Maybe it would work better on the State level than on the national level. I think most of these jobs in homes are not going to be done by large contracting firms; they are going to be probably handled by your local home construction companies. So that approvals maybe would be better handled on the State level, you know.

Senator BURDICK. Thank you very much.

Our next witness is Mr. Jim Scherer, from Denver, representing EPA.

I want to thank you, Mr. Scherer, for coming down here to Fargo for us today. We are pleased to have you.

STATEMENT OF JAMES SCHERER, REGIONAL ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY, REGION VIII, DENVER, CO

Mr. SCHERER. Thank you, Senator. I am Jim Scherer, regional administrator for Region VIII for the Environmental Protection Agency. As you well know, Region VIII covers a large geographical area of the United States, encompassing the States of North and South Dakota, Montana, Wyoming, Colorado, and Utah. Now, at the outset I would like to recognize your very positive and continuing interest in this serious environmental problem of radon gas in the indoor air environment.

I am pleased to have the opportunity to provide information on EPA's radon action program, particularly the implementation of the program in these six western States. My testimony will be similar to that given by Deputy Administrator Jim Barnes of EPA on EPA's radon program and radon legislation that was before your committee. However, I will expand upon Mr. Barnes's comments to include a description of the very crucial role of the Federal and State partnership in successfully achieving the fundamental objective of the radon action program, which is: reduction in the level of exposure to radon received by the United States population.

I also will comment on Senate bill S. 744, the State Radon Program Development Act of 1987, which, as you indicated, was recently passed by the Senate.

I won't go into a description of radon because I think speakers have already done a good job of that, except to comment again that we must remember that it is a natural occurrence and is present to some level in structures everywhere. Since the predominant geology of Region VIII is one of very high mineralization, there are significant areas in each of the Region VIII States considered to have the potential for elevated radon levels in homes. That elevated level that EPA has identified is four picocuries per liter.

To reduce the health risks attributed to radon, a program is needed to educate the general public on the risks at hand and to help citizens make informed decisions about ways to reduce such risks. The threat to human health posed by radon in the home environment is significant. As you had indicated in your opening remarks, EPA estimates that between 5,000 to 20,000 lung cancer deaths each year may be attributed to indoor radon exposure.

While the agency has not fully documented the extent of indoor radon exposures, EPA believes four to eight million homes in the United States may be found to have annual average radon levels greater than four picocuries per liter.

The potential threat of radon to human health has been an issue in many western States since 1960. Exposure to elevated indoor concentrations of radon gas was first recognized as a potential health problem in the 1960's when homes were found in Colorado that had been built with materials contaminated by uranium mill tailings. During the period 1978 through 1980, EPA and the Montana Department of Health and Environmental Sciences conducted a cooperative study of radon decay product concentrations in homes located in Butte, Montana. Nearly 14 percent of the more than 1,700 housing units surveyed in Butte exhibited working level

values greater than 0.02 working level, which is considered the top that it should be. These elevated levels were attributed to the unusual geology and extensive fracturing of the ground under Butte.

Most recently, EPA has assisted the North Dakota State Department of Health and Consolidated Laboratories in the conduct of radon measurements in homes located in the environs of abandoned uramiferous lignite mines near the City of Belfield. These measurements, as Mr. Mount indicated, were, however, conducted in only about 11 homes. They were conducted during the fall of 1983 through the summer of 1984, and they showed elevated radon concentrations in 50 percent of the surveyed homes.

The radon action program was established in 1985 in direct response to the serious radon problem discovered in the Redding Prong. The basic goal of the program is to significantly reduce the health risks of radon throughout the United States in partnership with other Federal agencies and the States. Within the division of responsibilities between EPA and the States, the EPA role is devoted to certain types of activities such as health research, national and geological mapping, national risk assessment, research and development of radon reduction procedures, development of technical training courses, and the development of public informational materials.

State responsibilities focus on the utilization of the scientific and technical information developed by EPA to respond to its local situations, particularly assisting citizens in diagnosing radon levels in homes and taking appropriate mitigative measures.

The division of responsibilities is based on the premise that the States are in the best position to take the lead in coordinating Federal and local efforts to address this unique environmental problem.

EPA's radon action program consists of four elements. The first is problem assessment, to assess the extent of the radon problem nationally. This element includes the national study to be conducted by EPA and EPA-assisted Statewide radon surveys.

Second, mitigation and prevention. We should do research, and are doing research, into economical methods of reducing radon levels in existing and new homes. Evaluation and mitigation techniques are developed and demonstrated to State officials.

Third, a capability development includes providing technical training courses for State officials and evaluating public and private measurement capabilities.

Fourth, public information to develop information publications to help citizens understand the health threat posed by radon and make decisions on the needs and procedures for radon reduction in their homes.

All the States in Region VIII, I am happy to say, have assumed responsibility for some of the activities within these four elements. I believe an effective Federal-State partnership has been forged with the States of Region VIII.

To illustrate the success of our collective efforts, I would like to highlight some of our accomplishments. Two States, Colorado and Wyoming, participated in the first year of EPA-assisted Statewide radon surveys. The recently published results of these two surveys showed a significant percentage of homes in both States will re-

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quire long-term follow-up measurements to assess the actual exposure potential and any possible need for corrective actions.

However, these findings do not change our predictions that the number of homes with annual average concentrations above four picocuries per liter will be on the order of 10 percent. Colorado's survey is now only 50 percent complete, with completion scheduled for the next heating season, 1987–1988.

North Dakota has been selected for participation in the second year of the Statewide radon survey program, and Utah will conduct a Statewide survey without direct EPA assistance.

EPA has loaned radon measurement equipment to North Dakota, enabling the State to perform follow-up measurements in homes found to have radon screening levels greater than eight picocuries per liter.

EPA provided 200 charcoal detectors to Montana for screening measurements in homes located in the Helena Valley, and EPA has analyzed private and public water supplies in Colorado, about 34 of them, and in Montana 20 of those, for radon concentrations.

The positive results of EPA's mitigation efforts have been very promising. Utilizing the radon reduction procedures developed and found successful for homes located in the Redding Prong States, homes in Colorado and Montana have undergone successful mitigation efforts.

State officials from North Dakota, Wyoming, and Colorado have attended EPA's radon mitigation and diagnostic training course. The recent availability of the course in a video cassette makes it accessible to State and local officials throughout Region VIII.

Montana and Wyoming have radon detection equipment for grab sample measurements. With the exception of Colorado homeowners along the front range area—that is Colorado Springs to Boulder—and the Grand Junction area, homeowners must perform their own radon measurements with detectors obtained by mail order. For these homeowners the EPA radon measurement proficiency program, with its listing of firms which have demonstrated the reliability of their detectors, has been a valuable source of information.

Finally, in public information the basic information need of the homeowner is met by two EPA pamphlets, both of which you have available here, I am pleased to see, "A Citizen's Guide to Radon: What It Is and What to Do About It," and "Radon Reduction Methods: A Homeowner's Guide." All six States in the region use these pamphlets to provide radon information to homeowners. Thousands have been distributed.

We are pleased with the results of our initial efforts. The Region VIII States are addressing their responsibilities and are helping citizens to reduce their risk from indoor radon. The Federal-State partnership can achieve our mutual goals of reducing the public health risk from radon.

Let me just comment briefly on the legislation that did just come out of your committee and pass through the Senate.

As Deputy Administrator Barnes indicated in a letter to the Committee, we believe this legislation strikes a proper balance in preserving and enhancing the Federal-State partnership which has and will continue to serve as the basis for the Administration's

radon policy. The proposal recognizes that State and local Governments must ultimately bear responsibility for assisting the public. At the same time, Senate bill S. 744 properly acknowledges that, particularly with regard to questions of national problem assessment as well as technical and financial assistance, there is a limited but unique and necessary Federal role.

Section 4 of the bill would expand and accelerate EPA's comprehensive program of technical assistance to the States, including activities such as establishing a clearinghouse on radon issues, developing radon measurement and device proficiency programs, demonstrating mitigation methods, conducting training seminars, and developing a national database.

Many of the technical assistance initiatives contained in this section are consistent with activities already in place as part of the agency's radon action program, and others represent sensible extensions of ongoing activities.

Section 5 would direct EPA to provide information to the public on firms and individuals proficient in radon measurement and mitigation. Participation in this program would be voluntary. An important aspect of section 5 is the authorization to establish and collect fees that would EPA radon measurement and mitigation proficiency programs to be self-supporting. This is consistent with the Administration's recently proposed user fee legislation.

Section 7 of the legislation authorizes a study of radon contamination in schools and a modest diagnostic and remedial demonstration program. The Administration believes it is important to obtain an accurate picture of radon levels in schools, and supports this provision.

Regarding section 6, grant assistance to States, the Administration recognizes the need for limited Federal financial assistance to help the States initiate radon-related programs. These Federal funds should assist in the development of educational materials, purchase of laboratory and radon measurement equipment, surveys of radon levels, training programs, and the establishment of data management systems.

The legislation's provision for a declining Federal grant share of not greater than 75 percent, 65 percent, and 50 percent over the three-year lifetime of the program places appropriate limits on the scope and duration of Federal grant assistance. In addition, the Administration supports the discretion given the EPA by S. 744 to allocate funds based upon the severity and extent of radon exposure within a State.

In short, the legislation authored by Senator Mitchell, Senator Chafee, and others in many ways represents a sensible extension of EPA's radon program activities. The Administration and EPA have endorsed S. 744 as a prudent and balanced approach to addressing a very difficult and unusual public health problem. We look forward to working with you and other members of the committee toward enactment of S. 744 in the 100th Congress.

Mr. Chairman, that completes my prepared remarks. I would be pleased to answer any questions you may have.

Senator Burdick. Thank you very much, Mr. Scherer.

We will now hear from our next panel, which consists of Dr. Glenn Lykken, professor of physics, University of North Dakota;

Dr. William Gosnold, professor of geology, University of North Dakota; and Norman Link, Jr., a student from Minot, North Dakota.

We will start with you, Dr. Lykken.

I would like to remind everyone again about the time element. If you could keep your remarks as brief as possible, we would appreciate it.

STATEMENT OF GLENN LYKKEN, PROFESSOR OF PHYSICS, UNIVERSITY OF NORTH DAKOTA

Mr. LYKKEN. Thank you, Senator Burdick. Friends, panel members, I am Glenn Lykken from the University of North Dakota physics department. Today I would like to talk a little bit about radon and how we have been investigating some of the decay products of radon.

Radon is the heaviest of the inert gases in a family including helium, neon, argon, krypton, zenon, and radon. These are called noble gases because they are inert and they do not participate in chemical reactions. Radon is colorless at room temperature but becomes a brilliant fluourescent yellow to red orange when cooled down to liquid air, and it is liquid near dry-ice temperature, about minus 80 degrees centigrade.

Radon was discovered in 1900 by Dorne, who called it radium emanation because it emanated from radium. In 1908 Ramsey and Gray isolated radon and called it nitron. Since 1923 it has been called radon.

There are 20 known isotopes of radon, all of which are unstable. They all decay by emitting an alpha particle. An alpha particle is a charged helium nucleus. The half-lives of these unstable isotopes lasts from 45 microseconds—that is, 45 millionths of a second—up to 3.8 days.

"Helium" is Greek for "helios," meaning the sun. It turns out that helium was first noted in an unknown spectral line which occurred during an 1868 solar eclipse. In 1895 helium was found in the mineral clevite, which is a uranium-containing mineral.

We can trace the effects of radon back about 400 years to 1576 in the Erz Mountains in Germany, where it was noted that the miners were suffering from a mountain sickness. It wasn't until about 1879 that this mountain sickness was shown to be lung cancer, and it wasn't until the 1930's, that radon was suspected of being the cause of the lung cancer. The radon came from the pitchblend which these miners were mining.

Pitchblend was mined because of its use in coloring glass. In the 1940's the Atomic Energy Commission noted that the radon levels in the U.S. mines were higher than those in Europe. In Europe, from 50 to 75 percent of the miners were dying of lung cancer in the late 1800's. In the 1950's better ventilation was provided in the mines, and by the 1960's the death rates due to lung cancer were reduced in parallel with the reduction of radon in the mines.

In the 1970's it was shown that the effects of radon radiation were the same as those due from atomic bombs and X-rays. It turns out that radon cancer is the most quantified effect of radiation insofar as over 24,000 miners have been studied since the 1940's.

Now, radon, of course, as we know, causes lung cancer, it is not radon itself but it is the radioactive daughters polonium-218 and polonium-214, which become attached to dust particles and smoke particles in the air, and they then enter the bronchia and emit these alpha particles. You recall that an alpha particle is a helium nucleus with high energy.

These highly-energetic alpha particles travel only about one one-thousandth of an inch in the epithelium, which is the inner cell layers of the organs, say, the bronchial tubes and the lungs, et cetera. They damage these cells by ionization; that is to say, they knock out electrons or they knock out atoms or they damage the DNA.

These cells rapidly reproduce and can lead to a form of cancer which has a latency of about 20 years; that is to say, it takes about 20 years before lung cancer appears.

Even a modest exposure to radon daughters as may occur in the home over a period of time can lead to lung cancer. It is suspected that radon in foods and drinking water may also cause gastric cancer and New Mexico studies have shown that counties with high uranium deposits—radon is in the decay chain of uranium-238—had high incidences of gastric cancer but counties which had no uranium deposits had no gastric cancers above the average.

It could well be that it was not the radon itself but the toxic trace elements associated with uranium ores such as selenium, cadmium, and arsenic.

Children spend more time in the house during cold weather, have smaller lungs and are more active than adults, this can lead to a larger internal radiation dose. There is evidence that the younger a person is exposed to this type of radiation, the greater the probability of developing lung cancer in later years.

At the university and at the Grand Forks Human Nutrition Research Center we have been studying the effects of radon on our whole-body counting since 1980, and we have noted that we can detect radon decay products in people through whole-body counting.

The daughter bismuth-214 emits high-energy X-rays, which we call gamma rays, these then can be followed with whole-body counting. We find that because radon is highly soluble in body fluids and in body fat, it becomes distributed throughout the body and we can then detect the presence of the decay product bismuth-214 through the whole-body counting.

Free-living volunteers have a higher bismuth-214 body content than do metabolic unit volunteers, and females also have 26 percent higher bismuth-214 counts per unit fat mass than do males. It's not at all surprising that free-living volunteers would have higher bismuth-214 counts than metabolic unit ones because it has been shown that commercial and public buildings have a lower radon content than private homes.

The reasons females have higher bismuth-214 counts per unit fat mass are not known, but it is well known that women have a higher percentage body fat than men and have a different fat distribution. Possibly this has something to do with it.

It has been suggested that lead-208, which is the stable end-product of uranium-238 be used as a monitor of lifetime exposure to

radon. Lead-208 would then end up in the body tissue, and by analyzing body tissues for 208 lead, you can then determine the lifetime exposure to radon.

We find bismuth-214 in all of our subjects, and we find that people who come from homes which have elevated radon concentrations relative to the average have much higher bismuth-214 counts than do people who come from homes with lower radon concentrations.

Evidently, the human body is a very sensitive detector of radon, as has been indicated through the evidence of lung cancer. Coupled with whole-body counting, the human body is a very sensitive detector of bismuth-214, which is a decay product of radon.

We have been trying to correlate bismuth-214 counts with body fats, sex, and radon exposure over the past few years. This is one of our primary interests in radon research. So we are not only interested in radon in the homes but also in seeing if the radon in the body then, the decay products, correlate with radon exposure.

Thank you, Senator.

Senator BURDICK. Thank you very much.

You have heard the testimony of the other witnesses today, have you not?

Mr. LYKKEN. Yes, sir.

Senator BURDICK. Do you agree that four picocuries is a safe level?

Mr. LYKKEN. It's a matter of who you listen to. But I think I agree. I mean, I do agree. With four picocuries per liter, you can expect something like 12,000 lung cancer deaths per million, and it's all relative—you've got to consider this in light of two things: The EPA has said that more than one death per million due to manmade carcinogens is too much. But we have to bear in mind, too, that it would be financially impractical to lower the level of radon on an average to below four picocuries per liter.

Senator BURDICK. But is four picocuries too low?

Mr. LYKKEN. I don't think it's too low. There is always the risk of death, and if you're the one who gets the cancer, who cares? I mean, so you just can't arbitrarily put it to nothing, because that's impossible: it's around us all over. So I think four picocuries is a reasonable compromise.

Senator BURDICK. Thank you very much.

Our next witness will be Professor Gosnold.

STATEMENT OF WILLIAM GOSNOLD, PROFESSOR OF GEOLOGY, UNIVERSITY OF NORTH DAKOTA

Mr. GOSNOLD. Thank you, Chairman Burdick. Good afternoon. Good afternoon, ladies and gentlemen. I am Will Gosnold, associate professor in geophysics at the University of North Dakota in the department of geology and geological engineering.

Health hazards from naturally occurring radon gas merit increased attention from several different scientific disciplines and civic interests. Finding answers to questions about the dangers of radon and how to effectively minimize or eliminate those dangers will best be achieved by coordinated, interdisciplinary research.

Communication of the findings of the scientific investigations to the public has great importance and is the joint responsibility of the investigating scientists and our political leaders. This public hearing in North Dakota comes at a time when public awareness of the hazards of radon is just growing to the level of general knowledge provided by frequent documentary reports by the news media. I commend Senator Burdick, Senator Burdick's staff, and the Committee on Environment and Public Works for their timely response to this matter.

The interdisciplinary approach to investigation of the problem of radon hazards may include physicians, physicists, geologists, hydrologists, chemists, engineers, and architects, just to mention a few. I am addressing the geological aspects of radon from the viewpoint of the geophysicist. My remarks pertain to the distribution of radon in the natural environment.

The distribution of radon in nature can be examined by considering three different but related factors: first, identification of the source for radon; second, the geochemical nature of its source; and third, the nature of migration of radon gas through soils.

Radon occurs naturally only as radon-222, a daughter isotope in the radioactive decay series of uranium-238. The scheme includes five radioactive isotopes between the parent uranium and radon-222 and seven radioactive isotopes between radon-222 and the stable lead isotope.

Two physical properties of radon affect its distribution. Radon is a gas that is heavier than air, and it has a very short half-life, about 3.85 days. Because radon is a gas, it can flow away from its source along pressure gradients, but due to its short half-life it tends to be concentrated close to its source. The nature of the occurrence of radon is essentially linked to the occurrence of uranium. Consequently, any study of the occurrence of radon must address the nature of the occurrence of uranium.

Investigations of uranium in the earth have been conducted for several different reasons. Physicists and isotope geochemists have studied the fractionation and distribution of uranium isotopes for radiometric dating. Geophysicists have extensively studied the distribution of uranium in the Earth's crust to determine its contribution to heat flow through the Earth's surface. Geochemists have studied the abundance of uranium in relation to other elements in larger studies of the chemical composition of the Earth and the solar system. Exploration geologists have studied the abundance of uranium as an ore.

As a result of these studies, we know a great deal about the distribution of uranium in the natural environment. However, we have not until recently considered the natural distribution of uranium from the standpoint of a health hazard. Consequently, although we can predict with good accuracy the content of uranium in most rocks and soils, we have not yet prepared geologic maps of uranium abundances that would be useful in assessments of health hazards.

Uranium occurs to some extent in most rocks of the Earth's crust. It subsequently occurs as a component of the soils derived from the chemical decomposition of those rocks at the Earth's surface as well as the solute in surface and groundwaters.

There are three naturally occurring isotopes of uranium. Their fractionation is such that it is constant in nature; they don't tend to separate from one another. Uranium abundances are measured in parts per million in solids, and the average uranium content of the Earth's crust is about four parts per million. The continental crust has an overall chemical composition that is essentially that of a granite, and to geologists granite is the typical rock of the continents.

Extensive sampling of all rock types indicates that granites tend to have the highest concentrations of uranium. Granites average about four parts per million uranium, the same as the whole crust, but they are known to contain more than 10 parts per million uranium in some areas such as parts of the southern and central Rocky Mountains, western Idaho, and the northern Appalachians.

Exposures of granite in the continents are relatively few and tend to be characterized by remote mountainous terrains. Most areas of the continents are covered with a one-to-two-kilometer-thick veneer of sedimentary rocks. Most surfaces are covered with soils that range in thicknesses from several centimeters to tens of meters. Sedimentary rocks and soils contain uranium that has followed a path of weathering—that is, chemical leaching from rocks such as granites—and has become incorporated in the sediments.

Uranium is chemically mobile in nature in oxidizing conditions and is deposited in reducing conditions. Sedimentary rocks containing the highest concentrations of uranium are shales, particularly black shales, and shales are comprised of clay minerals which concentrate uranium by adsorbing uranium ions under their surfaces by weak polar bonds. Black shales have high contents of organic materials which have a chemical affinity for uranium, and a geochemical environment at the time of deposition is a highly reducing environment.

Gray shales, such as the Pierre shale, a relatively thick, widespread formation in the northern and central Great Plains, are also deposited under reducing conditions and contain higher than the average concentrations of uranium. The source for uranium concentrated by shales is the uranium dissolved in seawater. The dissolved uranium derives from weathering of granites on the continents and is transported in oxidizing, slightly acidic surface waters to the sea. The entire process is a geochemical cycle that is relatively well understood by geochemists.

Soils derived from shales have high clay contents and under reducing conditions have the capacity to concentrate uranium. The soils of the Red River Valley—that is, the sediments of glacial lake Aggassi—were largely derived from exposures to the Pierre shale and were deposited under reducing conditions. Consequently, soils in the Red River Valley contain higher than average amounts of uranium. This uranium is the source for the radon gas in the Red River Valley.

Migration of uranium and radon through rocks, soils, and groundwater has also been studied to some extent, but much more needs to be done. Some of the problems we need to investigate are how radon in the soil responds to atmospheric pressure changes, changes in the water table, changes in soil temperature, and the effects of infiltration of acid rain.

We need to study soil permeability, the nature of pressure gradients that control the migration of soil gases in fluids, and the engineering and architectural controls that might be applied to keep migrating radon out of structures.

We must conduct our studies in coordinated, interdisciplinary investigations. An example of the need for such studies were provided recently by one of my colleagues, Dr. Glenn Lykken, who called my attention to a published investigation of radon in soil by two physicists in the eastern U.S. They had attempted to measure the radon of soils around a dwelling that had high concentrations of radon in the basement. Their approach was to use fission track detectors to measure the radon content of the soil a few centimeters below the ground surface.

At first, their approach seems logical and capable of providing useful results. They simply sought to measure the radon content around the house in situ. In situ measurements of radon in soils is the best way of obtaining accurate results because radon can escape from samples that are removed for examination in the laboratory.

However, the results of their study, which they published, indicated that the soil did not contain radon, and they concluded that the soil was not the source for radon in the dwelling.

One might ask, how could this be? There are several explanations that are not apparent in the single-discipline style approach. The near-surface region has an oxidizing environment in uranium not bound into resistate minerals—that is, those that cannot be easily chemically broken down—is leached out and carried away by infiltrating meteoric or irrigation waters, or perhaps in this case by watering the lawn. Without the uranium source near the surface, the soil cannot have a high radon content unless the site occupies a topographic load.

Another consideration is that radon is heavier than air and migrates through the permeable soil in response to pressure gradients. Gravitational forces cause radon to move downward, displacing lighter gases upwards. Topographic pressure gradients impart lateral forces that drive more dense gases toward topographic lows.

To accurately investigate the radon content of soils, we need to drill holes through the water table and measure the radon content in vertical profiles. To understand how radon is affected by climatic factors, such studies need to extend for several years to include a variety of natural conditions. To further understand the problem, we need to begin preparing maps of uranium in soils. This can be best done by drilling holes and obtaining samples in vertical profiles.

To augment these studies, we should investigate the pressure gradients extant in residential or other occupied areas to determine the possible direction of the migration of radon.

At this point I would like to conclude my remarks. I have much more on uranium in coal in western North Dakota, but that has already been mentioned by previous speakers. So I will leave that to them. Thank you.

Senator BURDICK. Thank you. Your entire statement will be made part of the record.

You mentioned we need better maps for radon areas.

Mr. GOSNOLD. I think I mentioned better maps for uranium in the soils.

Senator BURDICK. For uranium.

Mr. GOSNOLD. That is the primary source and the radon is very close to its source when it is detected.

Senator BURDICK. I see. Thank you very much.

Our next witness will be Norman Link, a student from Minot, North Dakota.

STATEMENT OF NORMAN LINK, JR., STUDENT, MINOT, ND

Mr. LINK. The first thing I would like to do is to thank you for inviting me here to give the results of my project.

In June of 1986 I wrote to a company in Walnut Creek, California, called Terradex Radon Monitoring Company and asked if they would send me 70 of their detectors.

Senator BURDICK. Would you bring the microphone closer to you?

Mr. LINK. Yes, sir. I asked them if I could use 70 of their radon monitors for the study I was going to conduct for my science project at school. They provided me with 70 of their Terradex radon monitors free of charge for my project.

Now, the first thing I had to do with my project was to get distribution people in the three major cities. I conducted a study of Minot, Fargo, and Grand Forks. Now, in referring to the area of Minot, Fargo, and Grand Forks, I am also referring to the area around that area. I put them in Minot. I also put those in Fargo. I also put a couple of detectors in Burlington, the Minot Air Force Base. Grand Forks Air Force Base also, in that area. Also, areas in and around Fargo is where I put detectors in.

Now, with each detector that I distributed to each person that I selected as a recipient of a detector, I sent them a letter which tells them how to open up the detector, how to fill out the slip attached to the Terradex radon monitor, and where to preferably put it.

I asked them to put the detector in the basement, since the highest levels of radon have been found in the basements because of the less air circulation you get. As the radon moves up through the home, the more air circulation will diffuse the radon.

After I sent these out, I told them to keep it in their home for three months. After that was done, I had to ask them to send the detector back to me. I sent the detector back for analysis to Illinois, and they gave me the results of each detector.

Now, the Terradex radon monitor has a piece of treated plastic in it. This piece of treated plastic picks up the tracks of the radon daughters. We take this piece of treated plastic out of the detector, they put it under a microscope, and they can see how many tracks that piece of plastic has, and they can determine your radon level.

This detector had very few tracks. That would indicate a very low radon level. However, this radon monitor had quite a few tracks, indicating a very high radon level.

After I received each participant's radon level, each participant then received a copy of a letter which I sent to all 70 people, which tells them what their radon level was, what different guidelines set by different councils such as EPA has set a guideline of 4.0 picocuries per liter, and then the National Council of Radiation Protection

measurements guidelines have set 8.0 picocuries per liter as their guideline. The American Society of Heating and Air Conditioning Engineers has set 2.0 picocuries per liter as their recommended action guideline.

Also with each letter was included a radon risk evaluation chart, which is pictured right here [indicating]. So if they had a radon level of, say, 4.0 picocuries per liter, they could go across here, and see it's right in about equivalent of 20 chest X-rays per year. And they can just go on up and down and see where the radon level is equivalent to.

Now, when the radon results came back, I took the average of each area at Minot and Grand Forks Air Force Base.

Senator BURDICK. Norman, would you take that mike and hold it in your other hand? We can't hear all you're saying here.

Mr. LINK. Now, the average for all the three cities came out as: Fargo had an average of 4.65 picocuries per liter, which is above the EPA's radon picocurie guideline; Minot was next with 3.44 picocuries per liter; and Grand Forks and the Air Force Base area was next with 3.90 picocuries per liter.

Although the whole City of Fargo had the highest individual level, the highest individual reading was in Minot, 11.1 picocuries per liter.

Now, according to my study, I had one detector at Hatte, North Dakota, and one detector at Minot in the city area. Two people are moving from the area in which they had their radon tested.

Are there any questions I can answer?

Senator BURDICK. What city had the highest numbers? Was it Minot?

Mr. LINK. Average numbers?

Senator BURDICK. Yes.

Mr. LINK. Fargo had the highest average.

Senator BURDICK. Pardon?

Mr. LINK. Average. Fargo had the highest average numbers.

Senator BURDICK. What city in North Dakota had the highest average numbers then?

Mr. LINK. Fargo.

Senator BURDICK. And what were they?

Mr. LINK. Fargo had the highest average numbers, over 4.0 picocuries per liter, but the highest individual reading was in Minot.

Senator BURDICK. I see.

Thank you very much, panel.

Our next panel will consist of: John Trestad, Fargo/Moorhead Homebuilders and the North Dakota Association of Builders; and Jerry Schlosser, president, North Dakota Association of Realtors; Susan Hunke, president, North Dakota League of Women Voters; Walter Hoff, superintendent of schools, Belfield, North Dakota.

Mr. Trestad, we would be happy to hear from you first.

STATEMENT OF JOHN TRESTAD, FARGO/MOORHEAD HOMEBUILDERS AND THE NORTH DAKOTA ASSOCIATION OF HOMEBUILDERS

Mr. TRESTAD. Thank you, Senator. I am happy to be here to represent the builders of the State of North Dakota.

This is an issue that we have been concerned about for some time. Radon contamination in new and existing homes is a genuine concern of the North Dakota Association of Homebuilders. The association and its members have been observing and anxiously awaiting more definitive data describing the real risk this natural health hazard poses. No builder in the State is interested in building a home unsafe for people to live in. In the extremely competitive housing market of today, no builder could survive a reputation for building unsafe homes.

The radon issue has become an emotional one in the homebuilding industry because at this stage of the learning curve this is this confusing, sometimes contradictory, and occasionally sensationalistic depictions of the hazards of radon contamination. It would be very convenient for the respective agencies and industries to hammer out specific requirements builders and homeowners could follow to protect against this hazard. This would simplify things for everyone, unless, of course, those requirements and guidelines were based upon incomplete information. The result could then very well be significant money spent without any assurance the problem would actually be solved.

The building industry and homeowners simply must be provided with sufficient data in order to understand the full extent of the radon problem and whether proposed prevention and reduction techniques will be successful. Without sufficient information, there should be no rush to draw up new Government regulations, we feel.

One end of the spectrum of argument contends that the cancer risk from radon exceeds that of all other radiation threats combined, while others maintain that incidence of lung cancer attributed to radon are clearly an exaggeration.

Both views come from the scientific community and represent cogent arguments. To which end of that spectrum does the huge homebuilding industry begin committing its limited resources when in reality those resources consists of the average family's ability to afford housing?

In assessing how to address the problem of radon in our homes today, the issue of risk must be fairly and realistically weighed. An EPA publication entitled "A Citizen's Guide to Radon," published in August of 1986, contains figures illustrating the number of lung cancer deaths out of a group of 100 people that scientists would attribute to exposure to specific levels of indoor radon. The figures assume that these 100 individuals spent 75 percent of their time in the dwelling for 70 years. This would leave only six hours per day for earning a living and pursuing domestic and leisure activities outside the home. Clearly, this does not reflect today's extremely mobile and active society.

Now, while these percentages and numbers may have statistical validity, they raise questions and confuse a great deal of people, and we think it's important for those representations to be clarified sometimes.

It is understood by the National Association of Homebuilders that some of the estimates of cancer deaths from radon are based upon data gathered from epidemiological studies of uranium miners and that serious scientific questions have been raised about

extrapolations from data comparing uranium mine workers at high exposure rates to homeowners at relatively low exposure rates.

The North Dakota Association of Homebuilders does not suggest the radon problem be minimized in any way. On the other hand, we are concerned about the effect of exaggerated statements being represented to the public through the media and other vehicles. We advocate a balanced, rational, and thorough approach to the issue to try to find the most workable and cost-effective solutions. At present, we feel more data needs to be collected before homeowners are compelled to spend even more money for housing, housing which is already beyond the reach of far too many families as it is.

It is our sincere hope that any and every group working to improve the radon problem gives careful consideration to the full range of consequences of the actions proposed.

Senator BURDICK. Thank you very much.

You are aware, are you not, that we are not embarked on any program as of yet?

Mr. TRESTAD. That's correct.

Senator BURDICK. This is preliminary fact-finding.

Mr. TRESTAD. We appreciate that effort.

Senator BURDICK. I think it's very important that we know where we're going, and that is why we're having these hearings.

I just wanted to ask one or two questions. You have heard the testimony, have you? Have you been here during the hearing? Are you concerned about insulation, weathering, is tightening a house up too much dangerous?

Mr. TRESTAD. Well, I can speak to that from a personal level. I am involved in a company that manufactures the air-to-air heat exchangers that have been referred to in other testimony today. That does reflect one of the mitigation measures.

I have a specific concern that it not be assumed to be the answer because it puts a company like ours in a difficult situation where expectations may be higher than what can be delivered. If a house can be brought down from 200 picocuries per liter to 100 picocuries per liter by added ventilation and other means, that may be terrific, but it's still not down at the four-picocurie level.

We are concerned about whether that four-picocurie level is realistic and can be achieved. And that is what the studies are meant to identify.

I think builders as a rule are working hard to gather more information, and there is more that needs to be gathered. But I think a lot of the mitigation measures can be affordable. That needs to be gotten out to the public, however.

Senator BURDICK. Well, as I said before, this information-finding we are engaged in right now.

Thank you very much.

Mr. TRESTAD. Thank you.

Senator BURDICK. Our next witness is Jerry Schlosser.

STATEMENT OF JERRY SCHLOSSER, PRESIDENT, NORTH DAKOTA ASSOCIATION OF REALTORS

Mr. SCHLOSSER. Thank you, Senator. I am Jerry Schlosser, president of the North Dakota Association of Realtors, and I do appreciate the opportunity to testify here today.

We have some concerns and observations to make. Moreover, we are looking for more information to share with our customers and clients. First of all, the North Dakota Association of Realtors has a need to know the extent of the problem, locations, amounts and radon levels, a clear interpretation of the problem so that we can best protect our customers and clients in the marketplace.

There is a concern over the dependability and costs of the testing methods. It seems that the more dependable method takes the longest to get the results. For someone who has just been transferred and needs to sell their home, they don't have a lot of time.

There is a concern over the costs of remediation. The cost of correcting the problem could cause the prices of homes to increase. That increase could force more and more buyers out of the buying market.

The radon issue creates a marketing problem for the brokerage community's standpoint. The biggest problem is the balance of the customer's or seller's interests with the obligation to the customers or buyers. The client's interests simply put, are marketing their home, obtaining their available equity, and moving to their new location. Now, all of a sudden, somebody from the real estate company tells a client they need to test for radon. The first question is, "Why me?"

The client's second question is, "What is it? The guy next door didn't test his house. This is going to kill every opportunity that I will have to sell my property. The appraiser and the lender haven't told me that I need to do this testing. Why should I listen to you?"

The bottom line is the State law requires the disclosure of the structural defects or dangerous conditions in a property. Those anticipated conditions may dramatically affect the value of a property.

Now comes the customer or the buyer and that person's family. We may sell a house to the individual who signs a waiver that says, "I acknowledge that there is radon in the house, but I elected to take it anyway," but further states, "I hold you harmless." This family has a two-year-old and a three-year-old child. It is believed that the statute of limitations on negligence does not begin to run until the child attains majority. Twenty years later there could be an action because you cannot waive the rights of your children.

Where the problem of radon gas exists, we have serious concerns: number one, the protection of the public; and number two, the reduction of exposure for owners and realtors to liability suits. The North Dakota Association of Realtors has a need for more information. Thank you, Senator.

Senator BURDICK. Well, thank you, Mr. Schlosser. That is the very reason for holding these hearings, to get more information. We are not taking any definite actions, as I told the gentleman preceding you, we are just trying to find out the extent of this problem.

It is a problem, I am convinced of that. There is a problem. To what extent it is, that is another question.

I thank you for your testimony.

We will now hear from Susan Hunke, president of the North Dakota League of Women Voters.

STATEMENT OF SUSAN HUNKE, PRESIDENT, NORTH DAKOTA LEAGUE OF WOMEN VOTERS

Ms. HUNKE. Thank you, Senator. My name is Susan Hunke. I am president of the North Dakota League of Women Voters, and I thank you for inviting our testimony today. I have learned a lot from the other testimony as well.

We take this opportunity to express some concerns that have arisen from our general awareness of the radon problem as it affects public health.

The league approaches this issue from the perspective of an organization promoting citizen awareness of important issues so that we can knowingly participate in the Governmental process. We do approach it from that viewpoint. We became aware of the problem, as did most citizens, through news reports over the last couple of years. Our concern intensified when we learned that North Dakota and the City of Fargo were being identified in these national reports as proven radon sites. We then contacted the North Dakota State Department of Health, asking what programs were being undertaken or considered for our areas, and you have heard testimony about the current programs.

What we have learned from these sources that we have contacted is that because of the relative newness of the radon problem, there is a real lack of Governmental planning and direction for the public to follow and there is a great uncertainty on the part of the public as to the true level of the risk of radon exposure.

We know there is a problem, that some of us are being adversely affected, but we also need to know what to do next. We need to know where radon infiltration is occurring, how serious the problem is, what those affected can do about the problem, and how to make the necessary corrections as well as how to deal with the health problems resulting from radon exposure. Widespread public information is very much needed, followed by specific directions about detection methods and about corrective measures to be taken.

We have also learned that the public will need to rely on monitoring and measuring devices to be used in homes. We therefore urge that these devices, whether purchased or obtained on loan from Governmental bodies, be extremely accurate and that instructions on their use be clear and precise so that the proper use will provide correct information.

In preparing this statement today, a number of questions arise: How will those risks be identified? Is enough known about the occurrence rate of radon infiltration to determine a priority schedule for monitoring and measuring? Have definite safety risk standards been established—none, small, or considerable? Are the health care costs attributable to radon being considered? Will financial assistance be available for monitoring and corrective measures? Have

the Federal, State, and local cooperative efforts been addressed? Should radon infiltration identification be part of the preconstruction information? Should this information be legally required to be known to potential buyers?

The league has no position on radon specifically, but we do have positions on environmental protection and pollution control. I would like to comment on the league positions relative to the Radon Program Development Act of 1987, recently passed by the Senate and expected compromises as the House and conference committee discuss this act and the appropriations to carry it out.

The league believes generally that although environmental protection and pollution control are responsibilities shared by all levels of Government, it is essential that the Federal Government provide leadership and technical and financial assistance. The Federal Government should have the major role in setting standards for environmental protection and pollution control. Other levels of Government should have the right to set more stringent standards. Enforcement should be carried out at the lower levels of Federal, but the Federal Government should enforce standards of the other levels of Government if they do not meet this responsibility.

On public participation, the public has a right to know about pollution levels, dangers to health and the environment, and proposed resource management policies and options. The public has a right to participate in decision making at each phase of the process and at each level of the Governmental involvement. Officials should make a special effort to develop readily understandable procedures for public involvement to ensure that the public has adequate information to participate effectively.

We feel adequate funding is needed to ensure opportunities for public education and effective public participation in all aspects of the decision-making process. The appropriate level of Government should publicize in an extensive and timely manner and in readily available sources information about pollution levels, pollution abatement programs, and resource management policies and options.

The hearing procedures and other opportunities for public comment like this one should actively encourage citizens' participation in that decisionmaking.

We support public education that provides a basic understanding of the environmental and social, economic, and environmental costs and benefits of environmental protection, pollution control, and conservation.

One suggestion we would make is that the distribution of the EPA publications dealing with this problem, "A Citizen's Guide to Radon" and the "Radon Reduction Methods" book, should be made available in sufficient quantities to communities which are known already to have a radon problem.

Thank you very much for this opportunity to testify. We have submitted written statements as well.

Senator BURDICK. Thank you, Ms. Hunke.

We are really pioneers in this field. I would say that 2 or 3 years ago radon was a mysterious word to a lot of people. We don't know the extent of the problem. We know that it's not good, but we don't know what quantities are acceptable. That is why we are having

these hearings, and that is why the Senate gave us the authority to go this far. We hope that as a result of these hearings and whatever the House does that we are better prepared to meet the problem.

So we want to thank you for your contributions, and those of all the witnesses today.

We have one last witness here, Mr. Walt Hoff, superintendent of schools in Belfield.

How are things in Belfield?

STATEMENT OF WALT HOFF, SUPERINTENDENT OF SCHOOLS, BELFIELD, ND

Mr. HOFF. Good afternoon, Senator. It really sounds like we're in pretty bad shape in more ways than one, I'm sure of that.

I would like to thank you, Senator Burdick, and your staff for the invitation to attend this hearing.

I personally became aware of the problem of radon gas and radon daughters during the early months of 1987. There had been isolated cases of private citizens having detection tests during February, March, and April. These people were using a variety of screening devices, including reports published by the North Dakota State Department of Health.

I became concerned, so I ordered radon traps from Scientific Analysis, Montgomery, Alabama. Following the prescribed procedures, our initial testing indicated that three areas of the school buildings were found to possess above-acceptable levels indicated by the EPA of below four p.c.i.'s per liter of air. The three areas showed 19.1, 13.7, and 9.1, which would indicate all three.

We conducted a second screening six weeks later and found the following results in a variety of places throughout the school buildings plus the same areas that we had screened the first time of 28.0, 2.0, 27.0, 1.4, 5.2, and 5.6.

I contacted a few of the private citizens who had had tests completed, for comparison. Some of these showed the following: 1.4, 2.4, 5.6, 16.9, and 9.6. Confirming the fact that most of the areas had screenings that in most cases indicated a higher-than-acceptable level.

As stated before, the area around the community of Belfield had experienced uranium strip mining during the early and middle 1960's. This could account for some of the high test results, as some of the fill used for the school construction was acquired from these areas.

During this time, there were two burn mills utilized by Geo Resources and Union Carbide which could also have an effect upon this area even at this later date.

We have diagnosed. Now we must remedy. What can my school district do to reduce the risk of cancer-causing agents and lower the level as much as we can? What cost are we talking about, and how can we pay for this?

A cost was mentioned before of $150 to $2,000 for an average home, a 2,000-square-foot home surface floor space. Now we're talking about 70,000 to 100,000 feet of floor space of the school building.

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So we are talking about a considerable cost factor there of doing some of the things that they had indicated before.

We are just completing a $180,000 asbestos removal project in our schools this summer. We were fortunate to receive a grant from EPA in the amount of $50,000. But the district cannot feasibly go into an air cleaning system such as an electrostatic precipitator or increased heat or air exchangers without some type of financial aid. This is a predicament that most schools will face. We need to protect our students and our patrons of this school district.

I would also like to add a couple of other items that were mentioned before by Mr. Mount regarding smoking. The Belfield Public School District is probably the only school district in the State which has just established a policy now where there will be no smoking in any and all buildings at any time during the day or during the night. Whether this is reflective with regard to the radon or not, it probably does have some relation to that.

Another bit of information is this: In about the last six to ten years there have been six to seven farmers living in the southern part of my school district who have passed away from some type of a cancer problem. Now, this could be reflective upon something in this area.

I thank you again for this opportunity, Senator Burdick, and Mr. Peterson, for this opportunity to present some of these findings that we have had here in our school district.

Senator BURDICK. Thank you very much.

I noticed in your testimony that these tests vary widely. You say you tested three areas: 19.1, 13.7, 9.1. Then we go down to the school buildings, and the record shows 28.0, 2.0, 27.0, 1.4, 5.2, and 5.6. It doesn't seem to have a common base. It varies.

Mr. HOFF. I think in one instance we tested during the time of spring break when no one was available in the buildings at hardly at all, so there was no air movement and it was the type of testing that we should have done. That was the second testing done. I think this is a little bit more conclusive at that particular time.

The other time, there was some movement within the buildings, and consequently I think what happened is that people were in there and movement was created by people opening doors, windows, and so on.

This was in a building which was a ground-floor building, built in 1978 with fill gathered from the northern part of our school district in which there was some uranium strip mining occurring. It was unfortunate that that was the only place we could find fill to provide for this.

Senator BURDICK. Well, this is the reason why we want to further studies done.

Mr. HOFF. That's right.

Senator BURDICK. We should know where we're going, because 1.4, 2.4, 5.6, there's nothing wrong with that.

Mr. HOFF. No, no, there isn't. In fact, the home that I live in right now is the last one there, the 5.6.

Senator BURDICK. When was that test taken?

Mr. HOFF. That was taken in—excuse me just a moment. I will pull out the testing results here.

Those were taken—May 6, I received the test results back on May 6—they were taken about two weeks prior to that. It takes about that long to receive the results back from the testing.

Senator BURDICK. Well, I want to thank you all for your testimony. You can be sure that the committee will go over this very, very carefully before any real action is taken in this area because we want to be sure before we move on this one.

Thank you all very much.

Mr. HOFF. Can I tell you one more thing?

Senator BURDICK. Yes, please do.

Mr. HOFF. I don't think there are any other school districts in the southwestern part of the State that have done any testing. I think probably Belfield has been the only one at this particular time.

Senator BURDICK. Well, you heard the prior testimony. There will be some testing this coming year, and we will know more about it after the year is out.

Thank you all for coming to the hearing. You have given some valuable information. The committee will look it over very carefully and evaluate it. Thanks for coming. That concludes the hearing.

If anyone has any statements they want to file, you can leave them at my office or mail them to me as you wish.

With that, we will close the hearing.

[Whereupon, at 3:20 p.m., the committee was adjourned.]

[Statements submitted for the record follow:]

Testimony on Radon in North Dakota
by
Dana K. Mount, Director
Division of Environmental Engineering
North Dakota State Department of Health
and Consolidated Laboratories
before the
U.S. Senate Environment and Public Works Committee
Public Hearing on Radon
Thursday, August 20, 1987
Fargo, North Dakota

Mr. Chairman. My name is Dana K. Mount. I am the Director of the Division of Environmental Engineering of the North Dakota State Department of Health and Consolidated Laboratories (Department) in Bismarck. The Department is responsible for implementing the State's Radiation Control Program and is consequently responsible for the development of the State's radon program. It is a pleasure to be here today to testify on the nature and extent of radon contamination in North Dakota and the steps being taken by the Department to respond to the problem.

Other panelists will be giving detailed information on what radon is, where it comes from, and what the health effects are. I would therefore like to briefly talk about how radon gets in a home, how radon is detected, where radon detectors can be obtained, how detectors are used, what test results mean, how radon can be mitigated, what the role of the Department has been, what radon levels have been measured in North Dakota, and what the future holds.

How does radon get into a home?

Radon, being a gas, can move through small cracks in the soil and rock on which a house is built. Radon can seep into a home through dirt floors, cracks in concrete floors and walls, floor drains, sumps, joints, and tiny cracks or pores in hollow-block walls. Radon also can enter water within private wells and be released into a home when the water is used. Usually radon is not a problem with large community water supplies, where it would likely be released into the outside air before water reaches a home. From limited data we have available, radon in ground water from individual wells does not appear to be a problem in North Dakota either.

In some unusual situations, radon may be released from the materials used in the construction of a home. For example, this may be a problem if a house has a large stone fireplace or has a solar heating system in which heat is stored in large beds of stone. In general, however, building materials are not a major source of indoor radon. The primary source of indoor radon is from the soil. This is especially true in North Dakota.

Outdoor radon levels generally do not pose a significant health hazard. Indoor levels are normally about 5-10 times higher than outdoor levels, but they can be several thousand times higher.

Virtually every home in the United States has some level of radon gas in its air (estimates suggest that average annual indoor levels range between 1-2 picocuries per liter). Most homes will not have levels high enough to require any action to reduce them; but, a large number of homes may. Radon levels can vary substantially from house to house, even among homes in the same area. The only way to be certain about the level of radon in a house, is to have it measured.

How is radon detected?

Since radon cannot be seen or smelled, special equipment is needed to detect it. The two most popular, commercially-available radon detectors are the charcoal canister and the alpha track detector. Both of these devices are exposed to the air in a home for a specified period of time and sent to a laboratory for analysis.

The concentration of radon in air is measured in units of picocuries per liter of air (pCi/l). One pCi/l represents the decay of two radon atoms per minute in a liter of volume of air.

The concentration of radon decay products in air are measured in units of working levels (WL). One WL of radon decay products roughly corresponds to the amount of decay products released by 200 pCi/l of radon in the air.

There are other techniques requiring operation by trained personnel which can be used to measure radon levels, but such techniques may be more expensive than the devices indicated above.

Where can radon detectors be obtained?

Homeowners in North Dakota have been and are encouraged to contact the Department; whereby, we will provide the homeowner a copy of the EPA pamphlet, "A Citizens Guide to Radon," which includes some of the same information I am providing today. We also provide a list of companies that provide radon testing services. All of the companies on the list we provide have successfully demonstrated their capabilities in measuring indoor radon through the EPA Radon Measurement Proficiency Program. The cost for having a home tested ranges from $13 to $50, depending on the company, type, and number of detectors one wishes to purchase.

How are the radon detectors to be used?

The EPA and this Department recommend a quick and relatively inexpensive initial screening test. If the results indicate the possibility of high radon levels, then follow-up measurements

should be taken to provide a more precise picture of the average radon concentrations throughout a home. The Department has adopted EPA-developed testing protocols providing detailed information on proper testing procedures. A screening test is a short-term measurement made to give the homeowner an idea of the highest radon level in their home.

The screening measurement should be made in the lowest livable area of a home (the basement, if there is one). All windows and doors should be kept closed for at least 12 hours prior to the start of the test, and kept closed as much as possible throughout the testing period. This is necessary to keep the radon level relatively constant throughout the testing period. Because of the need to keep the windows closed as much as possible, it is recommended that these short-term radon measurements be made during the cool months of the year. Also, it is suspected that higher radon levels are more probable in homes in North Dakota during the cool months or winter season.

In most cases, the screening measurement is not a reliable measure of the average radon level to which a homeowner and his family are exposed. Since radon levels can vary greatly from season to season, as well as from room to room, the screening measurement only serves to indicate the potential for a radon problem. Depending on the result of a screening measurement, follow-up measurements may be needed to give a better indication of the average radon level in a home. Generally the follow-up measurements are made over the period of a year. The Department strongly recommend that follow-up measurements be made before a homeowner makes any final decisions about whether to undertake major efforts to permanently correct the potential problem.

What the radon test results mean?

Once a homeowner receives the results from the vendor, the Department requests the homeowner inform the Department of these results and we then can discuss any further actions which may be recommended.

If the screening test results are above 4 pCi/l, follow-up measurements should be performed. If follow-up test results are above 4 pCi/l, mitigative measures should be considered to permanently reduce radon levels as much as possible. The higher the radon concentration is, the higher the risk is of developing lung cancer. The higher the radon level in a home, the quicker the mitigative action should be taken.

How can radon be mitigated?

The risk of lung cancer from exposure to radon depends upon the amount of radon entering a home and the length of time it remains in living areas. Some actions which may be taken immediately to reduce the risk from radon, which can be done quickly and with a minimum expense are:

- Stop smoking and discourage smoking in the home. By doing so, it should reduce the family's overall chance of developing lung cancer, as well as reducing the family's risk from radon exposure (Radon decay products attach themselves to smoke particles which may become lodged in the lung through inhalation.);

- Spend less time in areas with higher concentrations of radon, such as the basement;

- Whenever practical, open all windows and turn on fans to increase the airflow into and through the house. This is especially important in the basement;

- If a home has a crawl space beneath, keep the crawl space vents on all sides of the home fully opened all year.

While the above actions will reduce the risk from radon, they generally do not offer a long-term solution. Some long-term solutions to reducing radon in the home are:

- Sealing off entry routes - to reduce gas entry into a house, barriers can be placed between the source material and a living space. This can include covering exposed earth with concrete or a gas-proof liner, sealing cracks and holes in concrete walls and floors, covering sumps and placing a removable plug in untrapped floor drains.

- House ventilation - this method involves increasing a house's air exchange rate (the rate at which incoming fresh air replaces existing indoor air) either naturally by opening windows or vents, or mechanically through use of fans or heat recovery ventilators.

- Soil ventilation - soil ventilation prevents radon from entering the house by drawing the gas away from the foundation before it can enter. Active ventilation techniques include hollow block wall ventilation, sub-slab ventilation using drain tile suction, as well as wall and sub-slab ventilation using selected suction points. Care must be taken when installing these methods to seal major openings that could reduce suction.

No one technique can be relied upon to consistently reduce radon levels in every house. Each house must be evaluated to determine the source of potential entry roads before any mitigation approach is adopted. The EPA has successfully reduced radon levels in a number of houses and is continuing to research a variety of mitigation techniques.

What has been the role of the Department?

The Department became involved in radon measurement in the fall

of 1983 as a result of studies being conducted jointly by the Department and EPA (Region VIII, Denver office and Office or Radiation Program, Las Vegas) related to the reclamation of the abandoned uraniferous lignite mines in the western part of the State near the city of Belfield, North Dakota. To determine the impact of the mine sites and any underlying uraniferous lignite ore bodies, the Department and EPA placed a number of alpha track detectors in homes surrounding these mines. The results of this limited study led the Department and EPA to conduct measurements in some of the homes in the area using Radon Progeny Integrating Sampling Units (RPISUs) and Passive Environmental Radon Monitors (PERMs). These measurements were conducted through the summer of 1984. Because of limited financial resources, the Department used and continues to use equipment on loan from EPA as well as the laboratory services of EPA.

In 1984 and 1985, measurements were made in some additional homes in the Belfield area as radon gained more attention by the media on the local as well as the national level.

In November of 1985, a study by Lawrence Berkeley Laboratories was published in Popular Science magazine. The article that was published indicated that 35% of the homes in Fargo, North Dakota, could have radon levels which exceed 8 pCi/l, a level twice the EPA recommended guideline. Since that time, interest in the radon issue has risen to a level that resulted in the Department becoming more active in conducting measurements in all areas of the State. At that time, the Department began making measurements in homes upon request using the RPISUs and PERMs and then offering suggestions on remedial actions (if warranted) which the homeowner might wish to consider.

Since approximately mid 1986, because of the Department's limited resources, measurements in private homes have still been made using RPISUs and PERMs, but only after the homeowner has utilized the services of a private vendor for radon testing and reported any elevated measurement results (above 4 pCi/l) to the Department. Since January of 1987, the Department has selected a level of 8 pCi/l or greater before performing follow-up measurements with PERMs and RPISUs. At levels between 4 and 8 pCi/l, the homeowner is asked to consider purchasing an alpha track detector to determine the annual average radon concentration. The 8 pCi/l level established by the Department was for the purpose of maintaining a priority workload.

What levels have been measured in North Dakota?

Vendor results as reported by 114 homeowners indicate that approximately 50% of the homes monitored have radon concentrations which are equal to or exceed 4 pCi/l. Data has been collected from homes in 28 cities, of which 20 cities have at least one home with radon levels exceeding the EPA screening guidelines. The range of radon screening results reported to the Department is from less than 1 pCi/l to 247 pCi/l. Follow-up measurements

conducted by the Department have not shown levels greater than 40 pCi/l.

Mitigative measures have been completed or are being attempted in approximately 12 homes at this time. These mitigative measures have included sealing cracks in the basement foundation, venting sump soil gas outside and installing air-to-air heat exchangers. Some other homeowners which have elevated screening test results are using alpha track detectors to determine the annual average radon concentration in their home prior to considering any remedial action. The Department is essentially following the EPA's guidance as published in the EPA pamphlet "A Citizens Guide to Radon" and "Radon Reduction Methods."

What does the future hold?

Recently the Department submitted a proposal to participate in the EPA's States Assistance Program; whereby, a statewide radon survey would be initiated during the fall of this year. This August we were informed by EPA that we have been approved to participate in the program this fall. The Department expects to receive approximately 3,000 charcoal canisters for random radon screening tests. A total of 2,400 randomly selected homes will be tested across the State. The survey should provide valuable information to estimate the scope of the radon problem in North Dakota.

In the future, federal legislation, such as the Radon Program Development Act of 1987 recently passed by the Senate, would provide greatly need technical and financial assistance to the states such as North Dakota. The Department is concerned that North Dakota has a radon problem, but does not have the resources to investigate, educate, and mitigate. That is why the Department enthusiastically supports this Act, which provides technical assistance and funding from the federal level to the states.

This concludes my prepared testimony. I appreciate you giving the Department the opportunity to testify here today in Fargo. If you have any questions, I would be happy to answer them.

Thank you.

STATEMENT OF
JAMES J. SCHERER
REGIONAL ADMINISTRATOR
REGION VIII
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
UNITED STATES SENATE
FARGO, NORTH DAKOTA

AUGUST 20, 1987

Good afternoon, Mr. Chairman, I am James J. Scherer, Regional Administrator for Region 8 of the U.S. Environmental Protection Agency. Region 8 covers a large geographical area of the Western United States, encompassing the States of North Dakota, South Dakota, Montana, Wyoming, Colorado, and Utah. At the outset, I want to recognize your positive and continuing interest in this serious environmental issue, radon in the indoor air environment.

I am pleased to have the opportunity to provide information on EPA's Radon Action Program, particularly the implementation of the program in the Western States. My testimony will be similar to the April 2, 1987 testimony of EPA Deputy Administrator A. James Barnes on EPA's radon program and radon legislation proposed by Senator Mitchell and Senator Chafee. However, I will expand upon Mr. Barnes' comments to include a description of the very crucial role of the Federal/State partnership in successfully achieving the fundamental objective of the Radon Action Program, reduction in the level of exposure to radon received by the United States population. I also will comment on S. 744, the "State Radon Program Development Act of 1987," which was recently passed by the Senate.

Radon-222 is a naturally-occurring radioactive substance. It is a chemically inert gas formed in the soil by the radioactive decay of another naturally-occurring radionuclide, radium-226. Radium-226 and its parent compound, uranium-238, are present in all soils and rocks. Hence, radon gas is ubiquitous in occurrence and is present to some level in structures everywhere. Since the predominant geology of Region 8 is one of high mineralization, there are significant areas in each of the Region 8 States considered to have the potential for elevated radon levels in homes (annual average concentration greater than 4 pCi/L). These are areas of uranium resources, uraniferous phosphate deposits, black shales, granitic rocks (those containing uranium in concentrations greater than 4 ppm), and coal.

To reduce the health risks attributed to radon, a program is needed to educate the general public on the risks at hand and help citizens make informed decisions about ways to reduce such risks. The threat to human health posed by exposure to radon in the home environment is significant. EPA estimates between 5,000 to 20,000 lung cancer deaths each year may be attributed to indoor radon exposure. The Public Health Service estimates 15% of the 130,000 lung cancer deaths each year are due to causes other than smoking, radon being a major "other" cause. While the Agency has not fully documented the extent of indoor radon exposures, EPA believes 4 to 8 million homes in the United States may be found to have annual average radon levels greater than 4 pCi/L.

The detection within the last few years of extremely high radon levels in homes located in the Reading Prong (New Jersey, Pennsylvania, and New York) was met with public reaction which showed little or no prior

knowledge of radon and its health effects. To many, it was a newly-discovered pollutant. In contrast, the citizens of the Western States are much farther along the learning curve. The potential threat of radon to human health has been an issue in many Western States since the 1960's. Exposure to elevated indoor concentrations of radon gas was first recognized as a potential health problem in the 1960's when houses were found in Colorado that had been built with materials contaminated by uranium mill tailings. During the period 1978 through 1980, EPA and the Montana Department of Health and Environmental Sciences conducted a cooperative study of radon decay products concentrations in homes located in Butte, Montana. Nearly 14% of the more than 1,700 housing units surveyed in Butte exhibited WL values greater than 0.02 WL. These elevated levels were attributed to the unusual geology and extensive fracturing of the ground under Butte.

Most recently, EPA has assisted the North Dakota State Department and Consolidated Laboratories in the conduct of radon measurements in homes located in the environs of abandoned uraniferous lignite mines near the city of Belfield. These measurements--conducted during the fall of 1983 through the summer of 1984--showed elevated radon concentrations in 50% of the surveyed homes.

Due to the historical involvement with radon as a potential pollutant in homes, whether of natural origin or man-caused, the Western States and their citizens have an awareness and keen interest in the radon issue. Our job is to investigate the issue in a systematic manner and take action based on sound information.

EPA RADON ACTION PROGRAM

The Radon Action Program was established in 1985 in direct response to the serious radon problem discovered in the Reading Prong. The basic goal of the program is to significantly reduce the health risks of radon throughout the United States in partnership with other Federal agencies and the States. Within the division of responsibilities between EPA and the States (Chart I), the EPA role is devoted to certain types of activities such as health research, national and geological mapping, national risk assessment, the research and development of radon reduction procedures, development of technical training courses, and the development of public informational materials. State responsibilities focus on the utilization of the scientific and technical information developed by EPA to respond to its local situations, particularly assisting citizens in diagnosing radon levels in homes and taking appropriate mitigation measures.

The division of responsibilities is based on the premise that the States are in the best position to take the lead in coordinating Federal and local efforts to address this unique environmental problem. All States have an existing network of environmental, health, and radiation protection agencies with considerable experience in responding to local problems. States also can assist local governments that are beginning to develop monitoring and public education programs. In addition to this network, States have extensive technical knowledge and experience in areas such as local geology, building codes, real estate issues, and land use planning.

EPA's Radon Action Program consists of four elements:

1. Problem Assessment - assess the extent of the radon problem nationally. This element includes the national study to be conducted by EPA and EPA-assisted statewide radon surveys.

2. Mitigation and Prevention - research into economical methods of reducing radon levels in existing and new homes. Evaluation and mitigation techniques are developed and demonstrated to State officials.

3. Capability Development - includes providing technical training courses for State officials and evaluating public and private measurement capabilities.

4. Public Information - develop information publications to help citizens understand the health threat posed by radon and make decisions on the need and procedures for radon reduction in their homes.

All the States in Region 8 have assumed responsibility for some of the activities within these four elements.

I believe an effective Federal/State partnership has been forged with the States of Region 8. To illustrate the success of our collective efforts, I would like to highlight some of our accomplishments.

Problem Assessment

- Two Region 8 States, Colorado and Wyoming, participated in the first year of EPA-assisted statewide radon surveys. The recently-published results of these two surveys showed a significant percentage of homes in both States will require long-term, follow-up measurements to assess the actual exposure potential and any possible need for corrective actions (Tables I and II). However, these findings do not change our prediction that the number of homes with annual average concentrations above 4 pCi/L will be on the order of 10%. Colorado's survey is only 50% complete, with completion scheduled for the 1987/1988 heating season.

- North Dakota has been selected for participation in the second year of the statewide radon survey program. Utah will conduct a statewide survey without direct EPA assistance.

- EPA has loaned radon measurement equipment to North Dakota, enabling the State to perform follow-up measurements in homes found to have radon screening levels greater than 8 pCi/L.

- EPA provided 200 charcoal detectors to Montana for screening measurements in homes located in the Helena valley.

- EPA analyzed private and public water supplies in Colorado (34) and Montana (20) for radon concentrations.

Mitigation and Prevention

- The positive results of EPA's mitigation efforts have been very promising. Utilizing the radon reduction procedures developed and found to be successful for homes located in the Reading Prong States, homes in Colorado and Montana have undergone successful mitigation efforts.

Capability Development

- State officials from North Dakota, Wyoming, and Colorado have attended EPA's radon mitigation and diagnostic training course. The recent availability of the course in a video cassette form makes it accessible to State and local officials throughout Region 8.

- Montana and Wyoming have radon detection equipment for grab sample measurements.

- With the exception of Colorado homeowners along the front range area (Colorado Springs to Boulder) and the Grand Junction area, homeowners must perform their own radon measurements with detectors obtained by mail order. For these homeowners, the EPA Radon Measurement Proficiency Program with its listing of firms which have demonstrated the reliability of their detectors has been a valuable source of information. The RMP is a quality assurance program developed to ensure that those in the radon measurement business meet certain minimum standards.

Public Information

- The basic information need of the homeowner is met by two EPA pamphlets, "A Citizen's Guide to Radon: What it is and What to do about it," and "Radon Reduction Methods: A Homeowner's Guide." All six Region 8 States use these pamphlets to provide radon information to homeowners; thousands have been distributed.

We are pleased with the results of our initial efforts. The Region 8 States are addressing their responsibilities and are helping citizens reduce their risk from indoor radon. The Federal/State partnership can achieve our mutual goals of reducing the public health risk from radon.

PROPOSED LEGISLATION - STATE RADON PROGRAM DEVELOPMENT ACT (S. 744)

As set forth in Deputy Administrator Barnes' June 10, 1987 letter to Subcommittee Chairman Mitchell, we believe this legislation strikes a proper balance in preserving and enhancing the Federal-State partnership which has, and will continue, to serve as the basis for the Administration's radon policy. The proposal recognizes that State and local governments must ultimately bear primary responsibility for assisting the public. At the same time, S. 744 properly acknowledges that, particularly with regard to questions of national problem assessment as well as technical and financial assistance, there is a limited but unique and necessary Federal role.

Section 4 of the bill would expand and accelerate EPA's comprehensive program of technical assistance to the States including activities such as: establishing a clearinghouse on radon issues, developing volunteer radon measurement and device proficiency programs, demonstrating mitigation methods, conducting training seminars, and developing a national data base. Many of the technical assistance initiatives contained in this section are consistent with activities already in place as part of the Agency's Radon Action Program; others represent sensible extensions of ongoing activities.

Section 5 would direct EPA to provide information to the public on firms and individuals proficient in radon measurement and mitigation. Participation in this program would be voluntary. An important aspect of section 5 is the authorization to establish and collect fees that would allow EPA radon measurement and mitigation proficiency programs to be self-supporting. This is consistent with the Administration's recently proposed user-fee legislation, the "Environmental Protection Agency Fee and Charge Deposit Act of 1987."

Section 7 of the legislation authorizes a study of radon contamination in schools and a modest diagnostic and remedial demonstration program. The Administration believes it is important to obtain an accurate picture of radon levels in schools and supports this provision.

Regarding section 6, Grant Assistance to States, the Administration recognizes the need for limited Federal financial assistance to help the States initiate radon related programs. These Federal funds should assist in the development of educational material, purchase of laboratory and radon measurement equipment, surveys of radon levels, training programs, and the establishment of data management systems. The legislation's provision for a declining Federal grant share of not greater than 75%-60%-50% over the three year lifetime of the program places appropriate limits on the scope and duration of Federal grant assistance. In addition, the Administration supports the discretion given EPA by S. 744 to allocate funds based upon the severity and extent of radon exposure wtihin a State.

In short, the legislation authored by Senator Mitchell, Senator Chafee, and others in many ways represents a sensible extension of EPA's Radon Action Program activities. The Administration and EPA have endorsed S. 744 as a prudent and balanced approach to addressing a very difficult and unusual public health problem. We look forward to working with you and other members of the Committee toward enactment of S. 744 in the 100th Congress.

Mr. Chairman, that completes my prepared remarks. I would be pleased to answer any questions you may have.

Radon Action Program
Key EPA and State Responsibilities

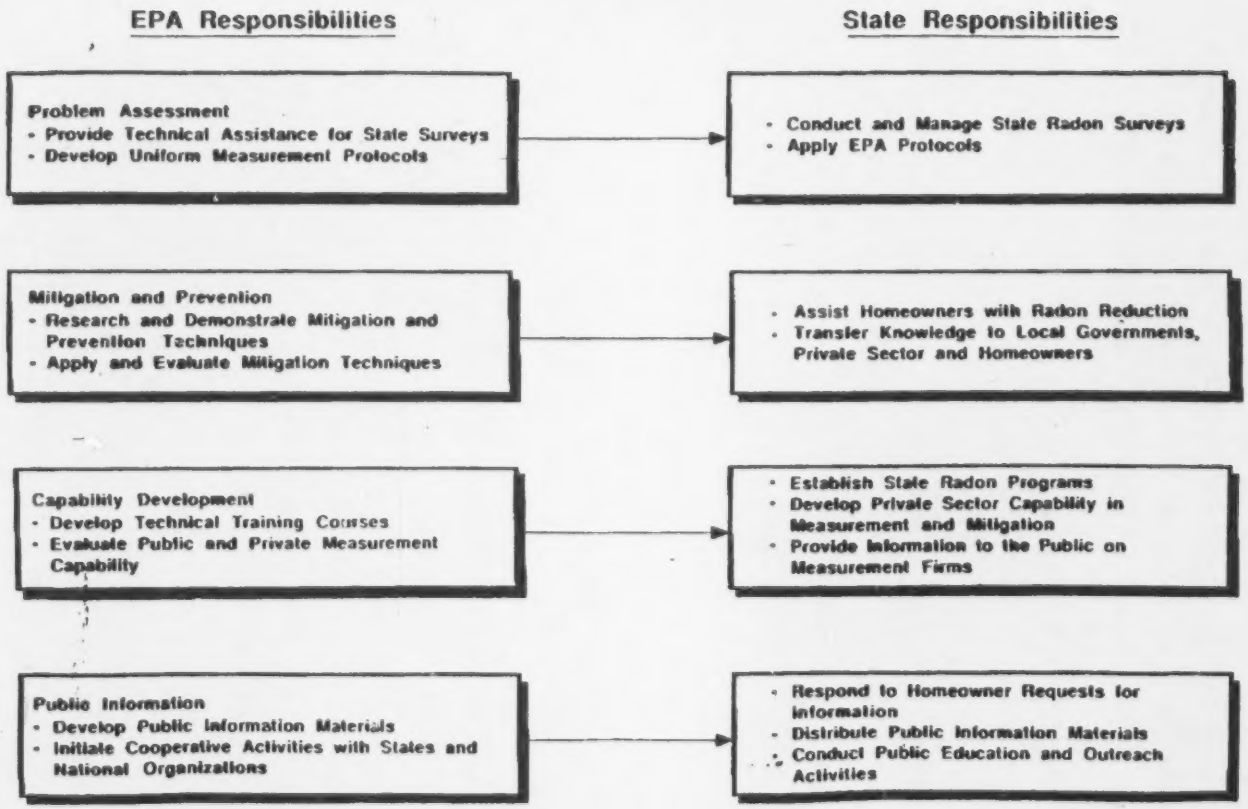
EPA Responsibilities
State Responsibilities
Problem Assessment
- Provide Technical Assistance for State Surveys
- Develop Uniform Measurement Protocols
- Conduct and Manage State Radon Surveys
- Apply EPA Protocols
Mitigation and Prevention
- Research and Demonstrate Mitigation and Prevention Techniques
- Apply and Evaluate Mitigation Techniques
- Assist Homeowners with Radon Reduction
- Transfer Knowledge to Local Governments, Private Sector and Homeowners
Capability Development
- Develop Technical Training Courses
- Evaluate Public and Private Measurement Capability
- Establish State Radon Programs
- Develop Private Sector Capability in Measurement and Mitigation
- Provide Information to the Public on Measurement Firms
Public Information
- Develop Public Information Materials
- Initiate Cooperative Activities with States and National Organizations
- Respond to Homeowner Requests for Information
- Distribute Public Information Materials
- Conduct Public Education and Outreach Activities

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TABLE I

Colorado

Distribution of Indoor Radon Screening Measurements

Radon Levels, pCi/L	Percent of Houses with These Levels*
0 - 4	81%
4 - 20	37%
> 20	2%

Average Level	4.8 pCi/L
Number of Houses Measured	900

* These values represent the actual measurements taken and may not be representative of all houses in Colorado.

TABLE II

Wyoming

Distribution of Indoor Radon Screening Measurements

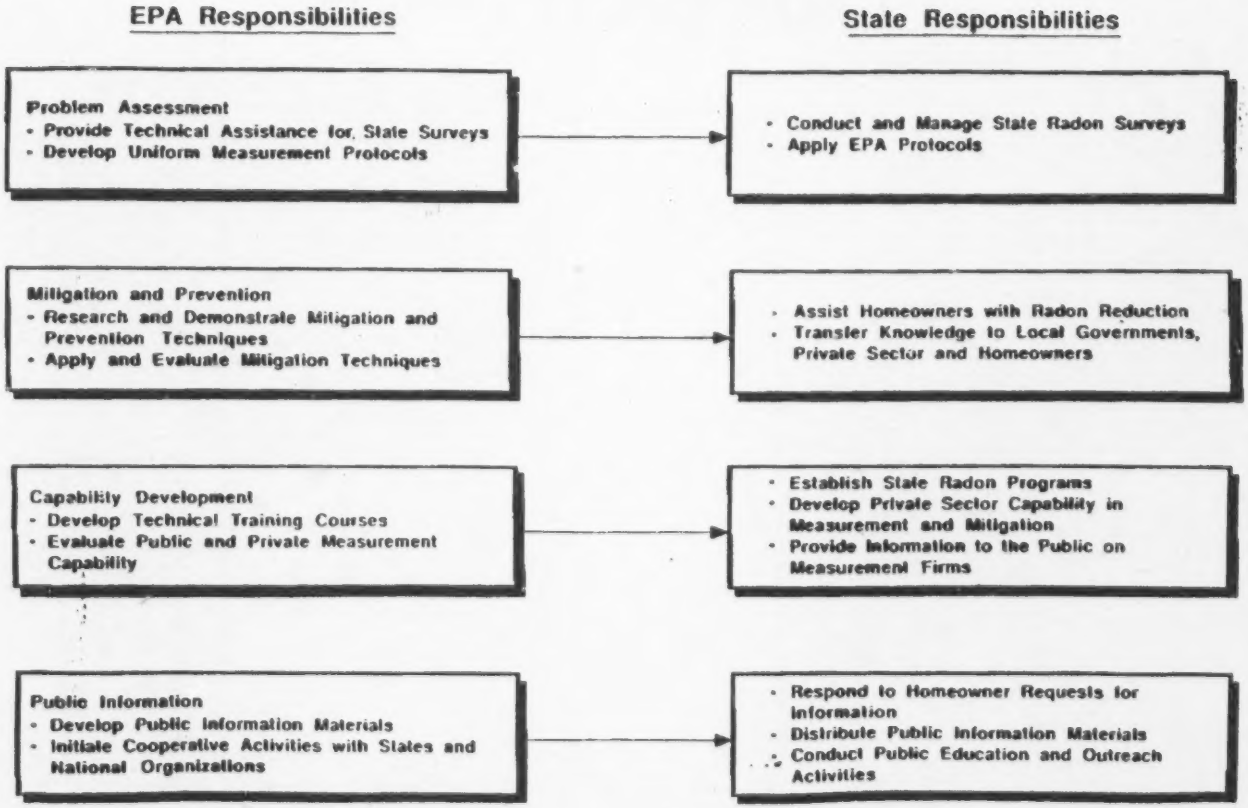
Radon Levels, pCi/L	Percent of Houses with These Levels*
0 - 4	74%
4 - 20	24%
> 20	2%

Average Level	3.6 pCi/L
Number of Houses Measured**	800

* There is a 95% certainty that these values represent all houses in Wyoming to within 4 percentage points.

** An additional 100 measurements were made on a volunteer basis.

Radon Action Program
Key EPA and State Responsibilities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RADON - A Naturally Occurring Health Hazard

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and

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United States Department of Agriculture
Agricultural Research Service
Grand Forks Human Nutrition Research Center

Grand Forks, North Dakota 58202

Testimony Before
United States Senate
Environmental and Public Works Committee
Hearing on Radon
1:30 pm Thursday
August 20, 1987
Holiday Inn
Fargo, North Dakota

1

Radon[1]

Radon is the heaviest inert gas, occupying the last place in the family of inert gases in the Periodic Table of the Elements. This family includes helium, neon, argon, krypton, and xenon. They are all chemically inert, and as a consequence they are referred to as noble gases. Radon was discovered in 1900 by Dorn, who called it radium emanation because it was observed to come out of radium.[2] Radon was first isolated in 1908 by Ramsay and Gray, who named it nitron: since 1923 it has been called radon. There are 20 known isotopes of radon, none of which are stable. They all decay by emitting a charged helium nucleus[3] (alpha particle) and have half-lives which vary from less than 0.000045 seconds (45 μs) to 3.8 days.

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1 A portion of this material is based upon Michael Lafavore's book "RADON - The Invisible Threat", Emmos, PA, 1987. Rodale Press, and the Handbook of Chemistry and Physics, 55th ed. Cleveland, 1974, CRC Press.

2 It has been estimated that every square mile of soil to a depth of six inches contains one gram of radium.

3 The existence of helium (Gr. helios, the sun) was first obtained during the 1868 solar eclipse. At that time Janssen observed a hitherto unidentified line in the solar spectrum. In 1895 helium was found in the uranium mineral clevite. All helium-4 found in wells in Kansas, Oklahoma, and Texas comes from alpha particle decay of radioactive material.

Two isotopes of radon, radon-220 emanating naturally from thorium and radon-222 from radium[4], are of particular concern to the general public because of their presence in the air we breathe. Ramifications of radon probably go back over 400 years to 1576 in the Erz Mountains of Germany where it was noted that mining of a uranium containing mineral called pitchblende (used as a coloring agent in glass) produced "mountain sickness", a cheat disease that was killing many of the miners. The problem was generally ignored for 300 years until in 1879 the "mountain sickness" was identified as lung cancer, and it was pointed out that 50 to 75 percent of the men working the mines of Southern Germany and Czechoslavakia were dying of lung cancer. However, it wasn't until the 1930's that radon gas emitted from the pitchblende was suspected of causing lung cancer.

In the 1940's an Atomic Energy Commission found that radon levels in United States mines were higher than in European mines and remedial steps were taken. At that time lung cancer death rates among miners were eight times higher than that of the general population. Better ventilation systems were installed and mine conditions improved in the 1950's and 1960's, concomitantly the lung cancer epidemic that had plagued miners for hundreds of years began to decline. However, a 1976 study of Czechoslavakian mines indicated that the decline in excess number of lung cancers above that of the general public was in direct proportion to the lowered radon levels. A later study compared radon's effects with those of equal amounts of radiation from A-bombs and x-rays and it was determined that lung cancer risks were the same from radon as from either of these. University of

Pittsburgh physics professor Bernard Cohen wrote in Consumer's Research magazine, "with all these data radon-induced lung cancer has become one of the most quantified health effects of radiation."

The primary radiation hazard arising from inhalation of radon and radon daughters attached to dust and smoke particles (a fraction of these particles is removed and retained in the bronchi for a period of an hour or so) comes from the alpha-particle emission (radon itself and its daughters). These energetic alpha-particles lose energy by ionizing the material through which they pass (removing electrons, charged atoms or breaking up DNA molecules). Their range is only a few centimeters (about an inch) in air and only about one thousandth of an inch in the epithelium (the inner surface of the bronchial tubes, lungs, body cavity and other organs). The cells of the epithelium reproduce so rapidly so that damaged cells can lead to a developing cancer. A latency of about 20 years exists between extended exposure to radon and detection of lung cancer; whereby even a modest exposure to radon gas and radon daughters attached to particulate matter, as may occur in the home over an extended period, can lead to lung cancer as well as other carcinoma. It is not known whether foods and drinking water containing radon lead to significant cancer of the stomach and gastro-intestinal tract. However, preliminary studies in New Mexico indicate that counties without uranium had a lower incidence of gastric cancer when compared to counties with significant uranium deposits. It is believed that a given radon exposure is more dangerous for children than for adults. Children spend a greater time in the house, especially during colder months, and they are more active than adults, which probably results

in a larger internal dose. Evidence continues to mount that the younger a person is when exposed to radiation, the greater the probability of cancer later in life.

We have shown that inhalation of radon and radon decay products that had accumulated on particulate matter in the air resulted in a distribution of bismuth-214 throughout the body (Lykken et. al., 1983). The presence of bismuth-214 was confirmed through wholebody counting of internally emitted gamma rays (similar to high energy x-rays) while monitoring total body potassium. Evidently radon is highly soluable in body fluids as are other noble gases (Pollack & Hims, 1986), and was absorbed into the blood through the lungs and distributed throughout the body where it decayed to Bi-214. We have been monitoring total body bismuth-214 content in Metabolic Unit (USDA - Agricultural Research Service - Grand Forks Human Nutrition Research Center) volunteers and in free-living volunteers for the past six years. We recently reported that the bismuth-214 content is higher in free-living volunteers when compared to their Metabolic Unit (MU) counterparts and that females have approximately 26 percent higher bismuth-214 content per unit fat mass than males (Lykken et. al., in press). In light of recent measurements that showed radon concentrations in public and commercial buildings to be nearly ten times less than for private homes, the lower bismuth-214 to fat mass ratios in MU volunteers are not unexpected (Cohen et. al., 1984). The higher ratios in females have not been explained to date although it is well known that females have a higher percentage body fat than males and that their body fat

distribution is different. Presumably radon is absorbed into the blood and distributed to body fat where it decays to bismuth-214. It has been suggested that environmental exposure to radon be determined through lead-206 body content, because stable lead-206 is the end product in the uranium-238 decay series (Wielopolski, 1987).

We were able to detect bismuth-214 emissions from all of our whole body subjects and were able to readily identify those who live in dwellings with elevated radon-222 content. Evidently the human body, through whole body counting of bismuth-214 emissions, is an extremely sensitive radon-222 monitor.

We are continuing to monitor bismuth-214 emissions and plan to determine if these emissions correlate with total body fat, sex, and radon exposure.

6

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Testimony Prepared for

The Senate Environment and Public Works Committee

Public Hearing in Fargo, North Dakota

by

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Grand Forks, ND 58202

Radon 222 in the Natural Environment

Health hazards from naturally occurring radon gas merit increased attention from several different scientific disciplines and civic interests. Finding answers to questions about the dangers of radon and how to effectively minimize or eliminate those dangers will best be achieved by coordinated, interdisciplinary research. Communication of the findings of the scientific investigations to the public has great importance and is the joint responsibility of the investigating scientists and our political leaders. This public hearing in North Dakota comes at a time when public awareness of the hazards of radon is just growing to the level of general knowledge provided by frequent documentary reports by the news media. I commend Senator Burdick, Senator Burdick's staff, and the Committee of Environment and Public Works for their timely response to this matter.

The interdisciplinary approach to investigation of the problems of radon hazards may include physicians, physicists, geologists, hydrologists, chemists, engineers and architects, just to mention a few. I am addressing the geological aspects of radon from the viewpoint of a geophysicist. My remarks pertain to the distribution of radon in the natural environment.

The distribution of radon in nature can be examined by considering three different but related factors. First, identification of the source for radon; second, the geochemical nature of its source; and third, the nature of migration of radon gas through soils.

RADON SOURCES

Radon occurs naturally only as ^{222}Rn, a daughter isotope in the radioactive decay series of ^{238}U. The decay scheme includes five radioactive isotopes between the parent ^{238}U and ^{222}Rn and seven radioactive isotopes between ^{222}Rn and the stable isotope ^{206}Pb. Two physical properties of radon affect its distribution. Radon is a gas that is heavier than air, and it has a very short radioactive half-life, i.e. 3.85 days. Because radon is a gas it can flow away from its source along pressure gradients; but, due to its short half-life, it tends to be concentrated close to its source. The nature of the occurrence of radon is essentially linked to the occurrence of uranium. Consequently, any study of the occurrence of radon must address the nature of the occurrence of uranium.

URANIUM IN ROCKS

Investigations of uranium in the Earth have been conducted for several different reasons. Physicists and isotope geochemists have studied the fractionation and distribution of uranium isotopes for radiometric dating. Geophysicists have extensively studied the distribution of uranium in the Earth's crust to determine its contribution to heat flow through the

Earth's surface. Geochemists have studied the abundance of uranium in relation to other elements in larger studies of the chemical composition of the Earth and solar system. Exploration geologists have studied the abundance of uranium as an ore. As a result of these studies, we know a great deal about the distribution of uranium in the natural environment. However, we have not, until recently, considered the natural distribution of uranium from the standpoint of a health hazard. Consequently, although we can predict with good accuracy the content of uranium in most rocks and soils, we have not yet prepared geologic maps of uranium abundances that would be useful in assessments of health hazards.

Uranium occurs to some extent in most rocks in the Earth's crust. It subsequently occurs as a component of the soils derived from the chemical decomposition of those rocks at the Earth's surface as well as a solute in surface and ground waters. There are three naturally occurring isotopes of uranium, ^{234}U, ^{235}U and ^{238}U. The most abundant isotope is ^{238}U, which is 137.5 times more abundant than ^{235}U. The least abundant isotope of uranium is ^{234}U which accounts for only about 0.0056 percent of the total natural uranium.

Uranium abundances are measured in parts per million (ppm) in solids, and the average uranium content of the Earth's crust is about 4 ppm. The continental crust has an overall chemical composition that is essentially that of granite; and, to geologists, granite is the typical rock of the continents. Extensive sampling of all rock types indicates that granites tend to have the highest concentrations of uranium. Granites average about 4 ppm U, the same as the whole crust, but they are known to contain more than 10 ppm U in some areas such as parts of the southern and central Rocky Mountains, western Idaho, and the northern Appalachians.

Exposures of granite in the continents are relatively few and tend to be characterized by remote, mountainous terranes. Most areas in the continents are covered with a 1 to 2 kilometer thick veneer of sedimentary rocks. Most surfaces are covered with soils that range in thickness from several centimeters to tens of meters. Sedimentary rocks and soils contain uranium that has followed a path of weathering, e.g.,chemical leaching, from rocks such as granites and has become incorporated in the sediments.

Uranium is chemically mobile in nature in oxidizing conditions and is deposited in reducing conditions. Sedimentary rocks containing the highest concentrations of uranium are shales, particularly black shales. Shales are comprised of clay minerals which concentrate uranium by adsorbing uranium ions onto their surfaces by weak polar bonds. Black shales have high contents of organic materials, which have a chemical affinity for uranium, and their geochemical environment at the time of depostion is a highly reducing environment. Gray shales, such as the Pierre Shale, a relatively thick and widespread formation in the northern and central Great Plains, also are deposited under reducing conditions and contain higher than average concentrations of uranium. The source for uranium concentrated

by shales is the uranium dissolved in seawater. The dissolved uranium derives from weathering granites on the continents and is transported in oxidizing (slightly acidic) surface waters to the sea. The entire process is a geochemical cycle that is relatively well understood by geochemists.

Soils derived from shales have high clay contents and, under reducing conditions, have the capacity to concentrate uranium. The soils of the Red River valley, i.e., the sediments of glacial lake Agassiz, were largely derived from exposures of the Pierre Shale and were deposited under reducing conditions. Consequently, soils in the Red River valley contain higher than average amounts of uranium. This uranium is the source for the gas in the Red River valley.

Migration of uranium and radon through rocks, soils and ground water has also been studied to some extent, but much more needs to be done. Some of the problems we need to investigate are how radon in the soil responds to atmospheric pressure changes, changes in the water table, changes in soil temperature, and the effects of infiltration of acid rain. We need to study soil permeability, the nature of pressure gradients that control the migration of soil gases and fluids, and the engineering and architectural controls that might be applied to keep migrating radon out of structures.

We must conduct our studies in coordinated, interdisciplinary investigations. An example of the need for such studies was provided recently by one of my colleagues on this panel, Dr. Glen Lykken of the Physics Department at the University of North Dakota. Dr. Lykken called my attention to a published investigation of radon in soil by two physicists in the eastern U.S. They had attempted to measure the radon content of soils around a dwelling that had high concentrations of radon in the basement. Their approach was to use fission-track detectors to measure the radon content of the soil a few centimenters below the ground surface. At first, their approach seems logical and capable of providing useful results. They simply sought to measure the radon content of the soil around the house in situ. In situ measurements of radon in soils are the best way of obtaining accurate results, because radon can escape from samples that are removed for examination in the laboratory. However, the results of their study, which they published, indicated that the soil did not contain radon, and they concluded that the soil was not the source for radon in the dwelling.

One might ask how could this be? There are several explanations that are not apparent in the single-discipline style approach. The near surface region has an oxidizing environment and uranium not bound into resistate minerals is leached out and carried away by infiltrating meteoric or irrigation waters, e.g., in this case by watering the lawn. Without the uranium source near the surface, the soil cannot have a high radon content unless the site occupies a topographic low. Another consideration is that radon is heavier than air and migrates through the permeable soil in response to pressure gradients. Gravitational forces cause radon to move downward displacing lighter gases upward. Topographic pressure gradients impart

lateral forces that drive more dense gases toward topographic lows.

To accurately investigate the radon content of soils, we need to drill holes to the water table and measure the radon content in vertical profiles. To understand how radon is affected by climatic factors, such studies need to extend for several years to include a variety of natural conditions. To further understand the problem, we need to begin preparing maps of uranium in soils. This can be best done by drilling holes and obtaining samples in vertical profiles. To augment these studies we should investigate the pressure gradients extant in residential, or other occupied areas to determine the possible direction of migration of radon.

Uranium in coal.

A few final remarks on another source for radon in inhabitated areas follow. These remarks apply particularly to regions where coal-fired power plants are a main source of energy. The geological environment of lignites in the Great Plains and the Rocky Mountains is conducive to uranium deposition through epigenetic processes, i.e., leaching from nearby volcanic source rocks and secondary deposition from groundwaters moving through the lignites. Supporting evidence for epigenesis as the primary mineralization process comes from observations that most of the uranium seems to occur as a urano-organic complex rather than in discrete uranium minerals. Geological investigations in the Great Plains and Rocky Mountain provinces have revealed numerous lignite deposits that are uraniferous to the extent that they contain marginally economic concentrations of uranium. The affinity of uranium for coal, the geological environment of the Great Plains, and the wide areal distribution of uraniferous lignites in the Great Plains suggest that many lignites in the province may be enriched in uranium. However, previous geological investigations focused on potentially economic uraniferous lignites, and generally disregarded non-economic deposits. Consequently, it is possible that slightly uraniferous lignites considered non-economic as uranium ores may be used as fuel in coal-fired power plants.

Extraction of uranium from coal.

During a period of exploration for uranium in the 1950's it was suggested that uranium might be obtained as a by-product of uraniferous lignites burned for fuel. Later, ashing of uranium-bearing carbonaceous materials was used to concentrate uranium in commercial operations in North Dakota and South Dakota. In these operations, uraniferous lignites were burned in kilns or in-situ and uranium was recovered from the ash by leaching with acid. Recently it has been suggested that uranium could be extracted from ashes derived from lignites in fluidized-bed combustion. The results of the commercial operations in the Dakotas and the laboratory tests demonstrate that uranium is concentrated in lignite ash. However there are

no quantitative estimates of how much of the total uranium in the lignite is ultimately retained in the ash. Results of a study by Morales and Gasos (1985) suggest that much uranium may become attached to limestone or sand used in the fluidized-bed process rather than remain in the ash.

Health Concerns.

The uranium contents of uraniferous lignites in the northern Great Plains are on the order of 0.005 to 0.02 percent uranium (Denson, 1959). Lignites considered as containing non-economic concentrations of uranium may have uranium contents on the order of tens to hundreds of ppm (Adams, 1969). Uranium concentrations in fly ash derived from these lignites could be increased several times over the concentrations in the lignite. The presence of uranium in the ash can present a potential health hazard from its daughter products, particularly ^{222}Rn and subsequent progeny because radon gas can be inhaled, become attached to lung tissue and subsequently cause lung cancer. If secular equilibrium is assumed for the uranium decay series, every member in the decay series is present in a fixed proportion to the quantity of ^{238}U present and the amount of radon can be estimated. In a condition of secular equlibrium there would be 4.3×10^{11} ^{238}U atoms for every ^{222}Rn atom. In one gram of ash containing 100 ppm ^{238}U, there would be about 6.2×10^{5} atoms of ^{222} Rn. The radiation from the radon alone would be about 35 picoCuries in the gram of ash. A radiation level of 1 piC/l for 10 hours/day is estimated to give a 1 in 300 chance of developing lung cancer. Accumulations in low areas around a radon source such as a porous and permeable ash pile could be increased several orders of magnitude over the concentrations in the ash. The above estimates of radiation are based only on radon. Including radon daughter products, all but one of which have half-lives on the order of minutes or seconds, increases the total radiation level by several orders of magnitude.